ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. LIV. No. 12. 220 Broadway, New York, September 21, 1905.

TABLE OF CONTENTS

LEADING ARTICLES:	Page
Reinforced Concrete Ribbed Arch Bridge, at Deer Park Gorge (illustrated); J. B. Strauss	293
Sanitary Engineering in the South and the Labor Question; J. N. Hazlehurst, M. Am. Soc. C. E.	294
Rapid Shaft Sinking at a Nova Scotia Coal Mine; W. H. Hyde, Assoc. M. Am. Soc. C.E.	295
Rapid Erection of Pier Shed Frame, Delaware, Lackawanna & Western R. R. (illustrated)	296
Fireproof Construction the Only Method of Reducing the Nation's Enormous Fire Loss; Alcide Chaussee	296
Annual Convention of the Roadmasters' and Maintenance of Way Association	297
Method and Cost of Concreting Jerome Park Reservoir, New York City (illustrated) H. P. Gillette	298
Cement and Concrete Tests at the St. Louis Exposition (illustrated); Richard L. Humphrey, M. Am. Soc. C. E.	300
Annual Convention of the New England Water Works' Association	305
A Symposium on the Relation of Copper Sulphate to Water Supply	306
Purification of Water by Copper Sulphate; D. D. Jackson	307
Annual Convention of the Central States Water Works' Association	311
The Water Softening Plant at Oberlin, O. (illustrated)	313
The New Sewage Works and Water Softening and Purification Plant at Columbus, O.; Julian Griggs	313
The Use of Oil on Macadam Roads and Oil-Asphalt Streets in California; Theodore F. White	314
Mosquito Extermination in the United States	314
EDITORIAL	309
Notable Achievements of the New England Water Works Association—The Labor Situation in the South—Some Examples of Rapid Shaft Sinking—Should Expansion Joints be Made in the Concrete Lining of a Reservoir?—The Concrete and Cement Tests at St. Louis.	
The Field for Engineers and Engineering Contractors in Architectural Building Work	309
LETTERS TO THE EDITOR	310
The Cubical Contents of a Wheelbarrow; James H. Harlow—Surveys for Mapping the Location of City Streets (illustrated); P. Doddridge—Establishing Irrigation Canal Tangents so that Cut and Fill will Balance (illustrated); M. H. Wright; "Tangent"—Establishing the Center of a Section of Land; W. C. Nespital; W. C. Smiley; F. Hodgman—Notes and Queries.	
ENGINEERING NEWS OF THE WEEK	315
PERSONALS	316
ENGINEERING SOCIETIES	316

REINFORCED CONCRETE RIBBED ARCH BRIDGE AT DEER PARK GORGE.

By J. B. Strauss.*

Deer Park Gorge is a reservation of 400 acres located near La Salle, Illinois, and is without doubt the most beautiful stretch of natural scenery near Chicago, while for wild and rugged grandeur it is surpassed by few, if any, landscapes in the United States. The Park is owned by Mr. F. W. Mathiesen, of La Salle, and while maintained as a private park, is open to the public under certain restrictions. It is traversed by numerous drives and foot paths, which lead to all the points of special interest and to observation platforms and shelter houses, built in chosen spots affording especially fine views. On the bluffs, overlooking the picturesque Vermillion River, there are a series of handsome cottages, as well as a power house for the light and water supply. There is also a club house and pavilion and an 18-hole golf course, which are used exclusively by the Deer Park Country Club, while the grounds proper have become the Mecca of summer pleasure parties from all the surrounding country.

Deer Park is divided into two sections by a natural gorge, which contributes not a little to its charm. This gorge is about 1¼ mile in length and varies in depth from 50 to 180 ft. The upper portion of the gorge is covered by a lake formed by means of a concrete dam 30 ft. in height, over which flows a small stream which is converted into mist before reaching the 40 ft. level below. The central portion, known as the Upper Dell, is a most interesting section, but, at present, is not easily accessible. The lower portion is termed the Lower Dell, and is by far the most picturesque. It contains caverns of enormous size and striking formation, while its perpendicular walls of St. Peter's sandstone tower so high as to shut out the sunlight. Between these walls gurgles a tiny stream, all that remains of the torrents which in bygone ages carved out these rocky caverns.

In the course of extensive improvements of the Park, made and still in progress, under the direction of O. C. Simonds & Co., landscape gardeners of Chicago, it became necessary to construct a foot bridge across the Lower Dell at a point where its depth was 60 ft. and its breadth 72 ft. Roemheld & Gallery, Engineers and Contractors, of Chicago, were low bidders for the work on a design of ribbed concrete steel bridge submitted by the writer,† and this design and bid were accepted. The work was begun April 2, 1905, under the personal direction of Messrs. F. M. Button, Engineer for the Simonds Co., and Mr. J. E. Roemheld, for Roemheld & Gallery, and was completed on May 5. The concrete was allowed to set 30 days before removal of the forms. On June 16 the bridge was subjected to a test load of 10 tons, and on June 17 was thrown up to traffic.

REINFORCED CONCRETE RIBBED ARCH BRIDGE OVER DEER PARK GORGE, LA SALLE, ILL.

The bridge is shown in half elevation and plan and in cross-section in Fig. 1, while views of the false work and of the completed structure are given in Figs. 2 and the front page engraving. It will be noticed that the clear span is 72 ft., the overall length 95 ft. and the width between hand railings 4 ft. 6 ins. The rise of the arch is 7 ft. 6 ins. with a camber of 4 ins. and the distance from the floor line to the level of the stream at the bottom of the gorge is 60 ft. The calculated live load was 80 lbs. per sq. ft., and the test load was 100 lbs. per sq. ft.

The feature of particular interest is the ribbed construction, which is clearly seen in the illustrations, and which, to the writer's knowledge, represents the first application of this principle to the construction of concrete steel bridges in the United States. The ribbed concrete steel bridge is a standard structure in Europe, where it is used in both highway and heavy railway work. In fact, the longest concrete-steel arch in the world is found in the central span of the ribbed bridge at Chatellerault, France. Notwithstanding this, ribbed bridges seem to have received no consideration whatever in this country, until the writer, realizing their superior economy and their great possibilities, undertook their improvement and development. The foot bridge of Deer Park represents the first fruit of this improvement.

The Deer Park bridge has two ribs, with arch rings of 16 ins. thickness and varying in depth from 20 ins. at the crown to 24 ins. at the haunches. From the arch ring to the floor line there is a 7-in. spandrel wall, on which is carried the 4-in. horizontal floor slab. Between the ribs are a series of 6-in. diaphragms, spaced 5 ft. c. to c., and extending from the floor line to the bottom of the arch ring. The office of these diaphragms is to take the wind load. Surmounting the floor is an open concrete hand railing, Figs. 3 and 4, with substantial railing posts. At the abutment the space under the floor is partially filled with stone as ballast, which was thought desirable to offset the effect of high wind on such an extremely narrow bridge.

Each arch rib is reinforced by four 1 × 1 ins. × 0.87 lb. steel T bars, located in the extrados and intrados of the rib. These bars are in four lengths; have wired splices, staggered, and are carried entirely through the abutting ends of the ribs, on the walls of the gorge. Two U-shaped steel tees 1 × 1 in. × 0.87 lb. constitute the reinforcement of each diaphragm, the horizontal arm of the U being imbedded in the diaphragm and the vertical arms running up through the ribs into the railing posts. In the floor there are eleven 1 × 1 in. × 0.87 lb. tees in each panel between diaphragms, running transversely so as to secure a support on the ribs. There are also two short 1 × 1 in. × 0.87 lb. tees placed longitudinally in the plane of the ribs at the center, and three flats 1 × ⅛ in. running across the transverse floor tees the full floor length. The spandrel walls of the ribs were not reinforced. All intersections of steel work were thoroughly wired together.

The steel used was the ordinary grade of commercial steel. The cement was the Owl brand of

*806 Chicago Opera House Block, Chicago, Ill.

†The original design for this type of bridge was made by the writer in connection with Mr. Geo. J. S. Collins, formerly engineer for the Reobling Co., Chicago.

German-American Portland Cement, made by the German-American Portland Cement Co., at La Salle. The concrete was hand mixed with screenings and ⅞-in. broken stone, the composition of the mixture being 1-2-4. A 1-in. mortar finish was applied to the floor as a wearing surface.

The hand railing, Figs. 3 and 4, was molded off the bridge, the hand rail proper and the latticed

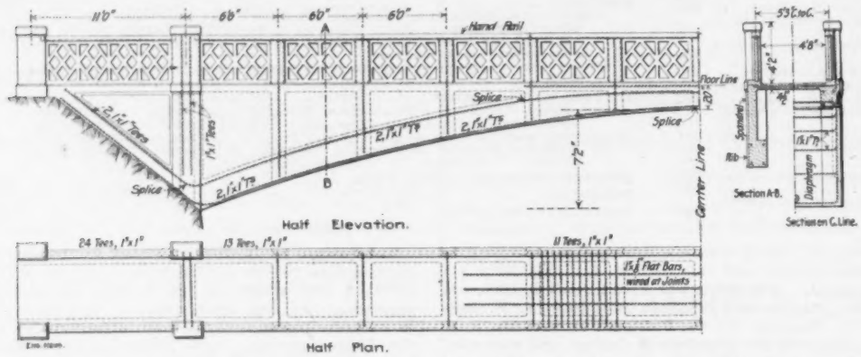


FIG. 1. HALF PLAN AND ELEVATION AND TRANSVERSE SECTION OF REINFORCED CONCRETE RIBBED ARCH BRIDGE, DEER PARK, LA SALLE, ILL.

panels being made separately. A series of boxes was prepared for the latter, each box containing a series of wooden blocks. These blocks occupied the spaces which in the finished panel are open, and each block was nailed to the box in such fashion as to be readily removable. The interior of the box was first plastered and the concrete was then put in place and rammed, scrap steel being used as reinforcement. After the concrete had begun to set, the blocks were removed, so that the final setting could take place without danger of cracking. As soon as the panel could be handled with safety, it was removed and stored until wanted, the form meantime being used again. Placing the railing in position was a simple matter, the posts and footing being recessed as shown in the detail, Fig. 3, so that it was only necessary to slide the panel in place and grout the joints. The hand rail proper was cast in two lengths, similarly recessed, and was placed in position in like manner.

The other parts of the bridge were molded in place. For this purpose a timber tower was erected in the canyon, as a center support for heavy cross timbers, the other end of which rested on the canyon walls, from which also intermediate supports were run out as shown in Fig. 2. On these cross timbers vertical bents were erected, each composed of 2 × 4 in. sticks suitably braced, and varying in length according to the curve of the arch. Then came a double layer of 2 × 10 in. planks, lengthwise placed flat, with staggered joints, and on these a floor of 2 × 10 in. transverse planks. These latter were extended 4 ft. on each side to form a working floor upon which the outer vertical casings of the arch rings and spandrels were built, and also the inner casings of the arch rings, at the proper distances apart. The outer casing, being high, was braced at intervals by knee braces.

The concreting of the arch ribs was first completed, the work being begun simultaneously at both ends and applied in layers as usual. The inner casings of the spandrel wall and the floor form were next put in place, and the concrete for these parts was then applied. All casings and forms were plastered before any concrete was put in place, and surfaces exposed to view were spaded. The bracing of the tower at the bottom was so arranged as to permit teams to be driven through it. This was necessary, since all materials for the work had to be hauled through the canyon from the mouth of the gorge at the Vermillion River. Material was unloaded in the bed of the canyon and hoisted up as required. All parts made off bridge were similarly handled.

The principal advantage of the ribbed bridge is its economy. This is most marked in structures larger than the Deer Park bridge, but in general averages from 25 to 35% for the same factor of safety. In highway and railway bridges, the ribs under the tracks can be made correspondingly heavier than the ribs under the roadway proper, thus realizing still further economy. Other advantages are the adjustability of the structure under settlement, and the accessibility of all parts for inspection. There is some advantage due to the additional form of work, but the writer has made improvements which overcomes this altogether and still further simplifies the construction and reduces the cost of this type of bridge. These improvements, together with the earlier improvements embodied in the Deer Park bridge, are covered by the writer's patents.

SANITARY ENGINEERING IN THE SOUTH AND THE LABOR QUESTION.*

By J. N. Hazlehurst, M. Am. Soc. C. E.†

With the phenomenal agricultural, commercial and industrial prosperity of the Southern States since the year 1890, came the pressing demand for the improved and scientific sanitation of her cities, and many of these, commencing about that time, undertook the extension of existing and fragmentary systems of combined and separate sewers, or arranged for the construction of new works, amongst these being Richmond, Norfolk, Chattanooga, Nashville, Atlanta, Macon, Charleston, Jacksonville, Brunswick, Montgomery, Birmingham and Houston, numerous of the smaller towns sooner or later following the good example of the more populous communities.

Of the larger municipalities of the South, Galveston and New Orleans alone remain unsewered, a condition which the latter city is at the present time actively and rapidly undertaking to remedy.

As compared with the progress and development of a majority of the other cities of the Union, those of the southern section have been admittedly backward in this as well as in many other municipal improvements, and it is only fair to that section to recall to the hypercritical the fact that only within a comparatively short period have the cities below the Mason and Dixon line [illegible] financial credit to undertake extensive public work [illegible] following the desolation wrought by civil war, [illegible] recent so-called reconstruction period with its bane [illegible] unscrupulous legislation, dissipated revenues and [illegible] posterity unborn to the repayment of vast indebt[illegible] from which no return was ever to be realized by [illegible] municipalities.

But with the passing of the shadow of those [illegible] days, a more prosperous era has dawned and a new [illegible] eration, fully alive to the demands of scientific [illegible] ment, determines to measure up to the highest standards of American civilization.

The Southern States, with increasing and diversified industries and development along all commercial lines, are still largely an agricultural country, comparatively sparsely populated and with its communities and [illegible] somewhat widely scattered, therefore the necessity for sewage purification works has not to the present time been pressing, nor considered a necessary adjunct to sewerage systems. Purification plants, however, have been constructed and are in operation at Houston, Texas; Danville, Ky.; and at Charlotte, N. C., the first being designed upon the broad-irrigation principle, while the two last follow the septic method, but neither of them are of especial interest requiring extended mention. The same may be said of the great majority of the sewer systems so far constructed in the South, none having been designed with notable departure from the current practice, except the works now being installed at New Orleans, and concerning which a brief outline may be of interest.

Situated at the mouth or delta of the Mississippi River and upon the shores of Lake Ponchartrain, topographical conditions about the city are such that a levee system is necessary for protection against the high waters, hence a gravity system of sewers becomes an impossibility.

In the general design of the New Orleans sanitary system the Engineer, Mr. George G. Earl, M. Am. Soc. C. E., has provided for the disposal of the sewage from collecting basins through the operation of three main and thirteen subsidiary pumping stations or lifts. The largest of these plants is designed to dispose of an ultimate flow of some eighty-two million gallons of sewage per 24 hours, discharging through a cast-iron force main of 48 ins. diameter into the river.

Following the usual practice, the unit of the system is the 8-in. vitrified sewer pipe, these laterals constituting 87% of the entire mileage. All pipe up to and including 36 ins. of vitrified clay, the larger mains up to the outfall of 6 ft. diameter being constructed of brick or concrete, alternate proposals being received for the two materials upon each section of contract work let. The general design of these sewers contemplates the ultimate construction of 900 miles of sewers of all sizes, while it is proposed to build at once some 400 miles, including the heavier sections. During the past two years more than 90 miles of sewers have been completed, about fifty miles of new work being advertised and let annually. At New Orleans the Mississippi River passes with considerable current and immense volume even at the lowest stages of dry weather flow, and little apprehension of objectional and deleterious pollution is entertained since calculations providing for a great increase in population, with allowance of 4 cu. ft. of sewage per second per 1,000 population, and to the extent of a daily discharge of 150 million gallons of sewage would show but solid matter, some 1 part in 86,000 by volume, and there passes during each

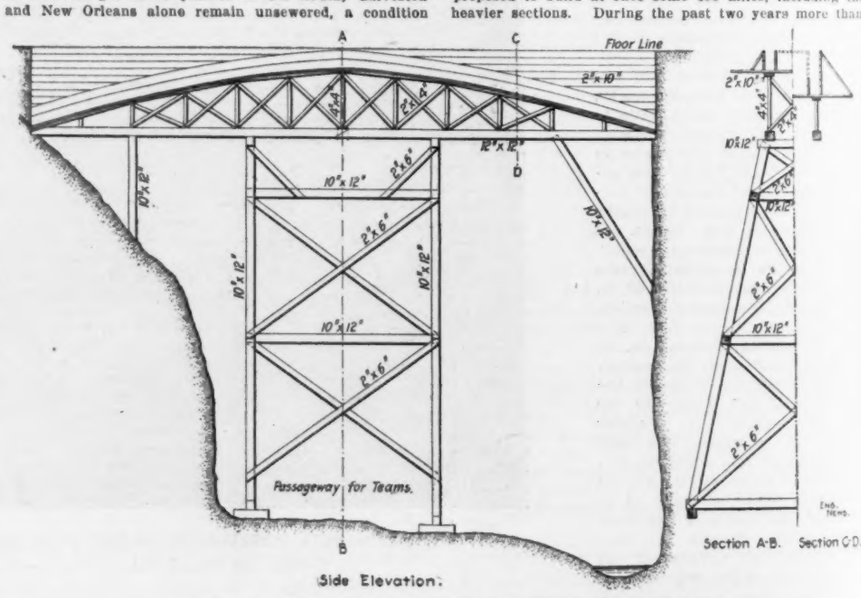


FIG. 2. CENTERS AND FORMS FOR DEER PARK BRIDGE.

*A paper read at the Montreal Meeting of the American Society of Municipal Improvements.

†City Engineer, Mobile, Ala.

minute of the day a volume of water equal to twice the amount of sewage proposed to be ultimately discharged in 24 hours.

The construction of these works offer many physical difficulties, owing to unstable soil conditions and its complete saturation at all points beneath the surface; an annual rainfall of more than 60 ins., generally confined to the summer months; the necessity for handling all seep water by pumping, and the almost certainty of encountering at any locality immense stumps of a virgin and extensive cypress forest long since buried from 2 to 8 ft. below the present surface of the ground. These natural obstacles combined with a most unsatisfactory labor situation have naturally been productive of high prices, the average for 8-in. pipe, with depth of 6 to 8 ft., being about 90 cts. per lin. ft. of pipe furnished and laid.

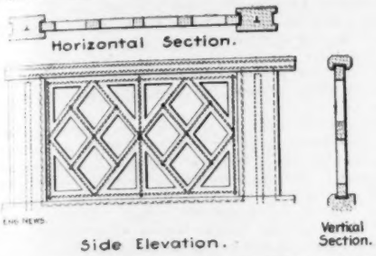


Fig. 3. Detail of Hand Railing, Deer Park Bridge.

In New Orleans, as in all of the southern coastal cities, especial provision must be made to secure stable foundations and effective pipe-jointing, the latter being of primary importance to prevent overcharging the sewers through the infiltration of ground water and as well to provide against the influx of water-borne sand. Notwithstanding these precautions, liberal provision is always made for the entry of ground-water, the allowance for that at New Orleans being assumed at some 26,000 gals. per mile of sewer, equivalent to a run-off of 0.003 cu. ft. per second per acre.

Eighty gallons per day is the calculated per capita provision for household waste and 20 gals. for infiltration, the design of these sewers therefore being to provide for 100 gals. of sewage and ground-water per capita of assumed population.

For the reasons given, the Engineer responsible for secure foundations and a limited quantity of ground-water must exercise especial care both in actual construction and in the preparation of specifications governing such work. The following is an excerpt from a set of specifications drawn by the writer for sewer construction under such conditions:

> In soft ground or where in the opinion of the Engineer the soil is of such nature as to endanger the alinement of the sewer, lumber or other materials shall be placed as directed to secure a suitable foundation. Where quicksand is encountered, special foundations may be ordered by the Engineer, but in general the construction at such spots shall consist of sound 2 × 12-in. planks, laid longitudinally, either with or without cross-stringers or sills, as may be ordered.
>
> Along the foundation so prepared the pipes shall be laid, wooden wedges being inserted under their barrels in such manner as to raise the bells clear of the foundations.
>
> After joining in the usual manner, a bandage or wrap of cheese-cloth or similar approved material shall be tied about the connection in such manner as to fully protect the cement joint until after its initial set. The cost of such work shall be estimated at the price bid for "Lumber in Place."

With every public as well as private enterprise of the South of to-day the labor question has become a most significant, almost a dominant factor, and in view of its increasing importance its brief discussion here may not be out of place.

Of something more than 8,000,000 American negroes or persons of African descent, 90% reside in the Southern States and form almost entirely its laboring class, and seldom upon public works or elsewhere is the white man a competitor for strictly manual labor.

Without offering in comparison the economic value of the negro as a laborer in the past, all qualified observers agree that the colored individual of the present generation has deteriorated physically, and as a laborer is non-dependable and inefficient. Meanwhile the industrial expansion of the South has produced a labor demand which is neither being supplied by natural increase of the native population nor augmented by newly arriving aliens; hence in the South at the present time the labor situation is acute and is of such importance in connection with public improvements as to fairly merit this digression from the subject matter of this paper.

As evidence of irregularity and the non-dependability asserted, from the carefully analyzed statement of constructive operations over which the writer has had jurisdiction during a period of twelve months just passed, and where more than $10,000 has been paid in wages alone, exclusive of holidays or when work was impossible on account of weather conditions, the average of the actual time employed as contrasted with a possible opportunity for work amounted to 59.6%, or simply stated, the negro laborer was willing to work at exceptional wages and preferred employment only a little more than one-half of his time for the twelve months. For the purposes of comparison with white labor, the writer secured information along these lines from a division engineer of the New York Rapid Transit Commission, who writes, "I find that taking fifty Italian laborers, they made 17,608 hours out of a possible 20,000 hours, making 88% full time."

On railroad work, which for many reasons offers peculiar attractions to the negro laborer, the same story of lack of continuity and indolence is reported as may be inferred from the following quotation from a late letter from one of the superintendents of the Southern Railway:

> During the month we were obliged to employ 706 men to do the work which under other circumstances 340 men could have performed; in other words, the men instead of averaging 26 days per month, actually averaged about 12 days each.

Under the stress of circumstances the competition for labor in the South has led to a steady increase in wages, many cities paying from $1.50 to $2 for unskilled labor, $1.80 being the average for negro sewer men on contracts aggregating more than $200,000 in New Orleans and with which the writer was indirectly connected during the past year.

With white employees, an increase of wages is generally followed by a marked additional effort, but an advance in the negro's wage scale produces just the opposite effect, since he works only sufficient for actual maintenance, and augmented wages is followed by a direct and corresponding reduction of effort.

The improvidence and shiftlessness of the average negro in the South may be best illustrated from some such record as that shown by the Sexton's annual reports, which compiled for the past seven years shows that of the entire number of negro deaths in Mobile County, Alabama, for the average fiscal period, more than one-half have been buried as paupers at the public expense, and the extent of this economic loss may be understood when the fact is stated that about one-half the entire population of the county quoted, or something like 20,000, are persons of negro descent.

The recitation of these facts in connection with the labor situation at the South is but the concrete expression of distressing economic conditions only too familiar to all employers in that section of the country. From long and familiar association with the colored individual and masses, the Southern white man has been willing to overlook the many weaknesses and failings of the negro laborer, but in the progress of the nation no longer can be postponed the realization of the industrial and economic incubus represented by the negro race at the present time, and there has arisen an imperative demand for more dependable labor in every vocation and in all fields of human endeavor.

In the South the natural increase is deficient both in numbers and quality, and it is now recognized generally that the only hope for a satisfactory solution of the labor problem is through desirable immigration; its judicious selection, and proper distribution.

The questions of labor and immigration are of vital interest to any engineering or industrial proposition in the South, and the proper direction of immigration is one which must appeal to all sections of the United States; but with particular force to those whose effort it is to secure a satisfactory labor for municipal improvements of the first magnitude. Under the haphazard policy of the United States permitting indiscriminate immigration of all nationalities except the Chinese, and relying upon a small class prescription as applied to individuals, with an absence of all effort to regulate or direct the influx of aliens, undesirable admissions and unnecessary congestion is a certain assumption.

As evidence of the inconsistency in the matter of distribution, from the reports of the Commissioner General of Immigration for the fiscal year, the ultimate destination of something more than four hundred thousand foreigners is given as being the two states of New York and Pennsylvania, while of nearly a million immigrants, North Carolina received 112, while South Carolina's quota was 95 new arrivals.

Conclusions are obvious although space permits no further amplification, but before concluding, incidentally it is suggested that the states of the union should make careful study of the immigration laws of the great Dominion of Canada and learn a lesson from her procedure and legislation governing immigration.

FIG. 4. VIEW SHOWING FLOOR AND HAND RAILINGS, DEER PARK BRIDGE.

RAPID SHAFT SINKING AT A NOVA SCOTIA COAL MINE.

By W. H. Hyde,* Assoc. Am. Soc. C. E.

Unusual progress for rock excavation was made in the sinking of a coal mine shaft at Stellerton, Nova Scotia, during the month of August, 1905. The work to which reference is had comprised the sinking of a new shaft (No. 2) and the deepening of an old shaft (No. 1) for the Acadia Coal Co., Ltd., Mr. Charles J. Coll, General Manager. Both shafts were in rock and both were 12 ft. 4 ins. × 24 ft. in size.

Ground was broken for the No. 2 shaft on April 26, 1904, and the sinking was completed at a depth of 1,016 ft. on July 17, 1905. On Aug. 1, 1905, No. 1 shaft was 982 ft. deep, of which depth 966 ft. were timbered; on Sept. 1, 1905, this shaft was 1,110 ft. deep of which depth 1,066 ft. were timbered. The progress during the calendar months was therefore 128 ft. sunk and 100 ft. timbered. During the month there were 4,014 buckets of muck hoisted, making an average of between 32 and 33 buckets per foot of shaft sunk. The bucket contains 22 cu. ft. water measure. Work was prosecuted continuously six days in the week by eight-hour shifts; there being no change in the personnel of the shift for drilling, mucking or timbering.

In the excavation two shaft bars and four drills were used in each shaft. Ingersoll-Sargeant D24 drills were used, and 12-ft. holes were drilled. A special tubular bucket was used to carry the long steel in and out of the shaft. Cylindrical steel buckets were used for mucking. There was a cross-head traveller above the bucket which moved in permanent guides that were extended to the bottom of the timber about once a month. A simple automatic dog in the head frame caught and held the cross-head while the bucket was hooked to a bull chain, running clear of the shaft and dumped direct into the muck car.

Owing to the treacherous nature of the rock timbering was done by two methods according as circumstances required. Our method consisted of hanging the timber one set at a time with iron rods. After 35 ft. of timber was thus placed the next timbering would be built up on anchor timbers placed in hitches in the wall. This method of hanging timber was used only in bad rock where it was necessary to timber every 10 to 20 ft. During all last winter all timber had to be steamed just previous to lowering it into the shaft.

The power plant used in the work was as follows: Until July, 1905, Lidgerwood friction engines were used for hoisting. In July a new hoisting engine was installed at shaft No. 1. This engine has 20 × 30-in. cylinders and parallel, smooth drain 72 × 90 ins., and was built by the Exeter Machine Works of Pittston, Pa. The new engine makes the hoist in about 30 seconds. The balance of the power plant consists of two 125-HP. Sterling boilers, one Ingersoll-Sargeant cross-compound air compressor, with a capacity of 1,500 cu. ft. of free air per minute, and two direct connected Sturtevant fans with a capacity of about 20,000 cu. ft. of air per minute.

The work described is being done by Mr. W. F. Patterson, Contractor, Pittsburg, Pa.

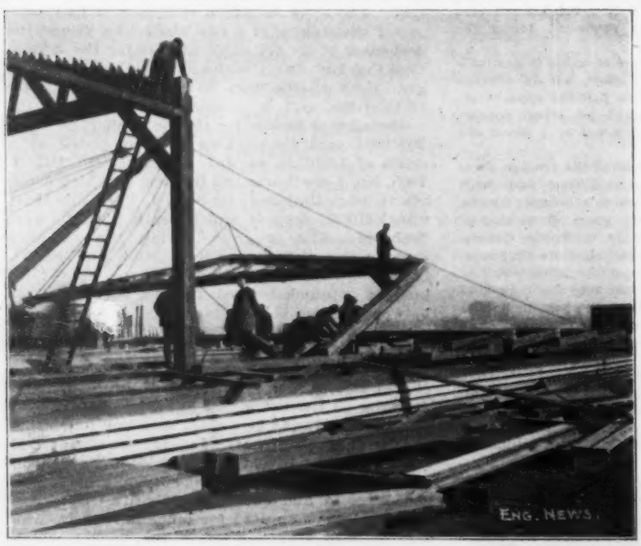
*Superintendent of Work for W. F. Patterson, Contractor, Lourdes, Pictou County, Nova Scotia.

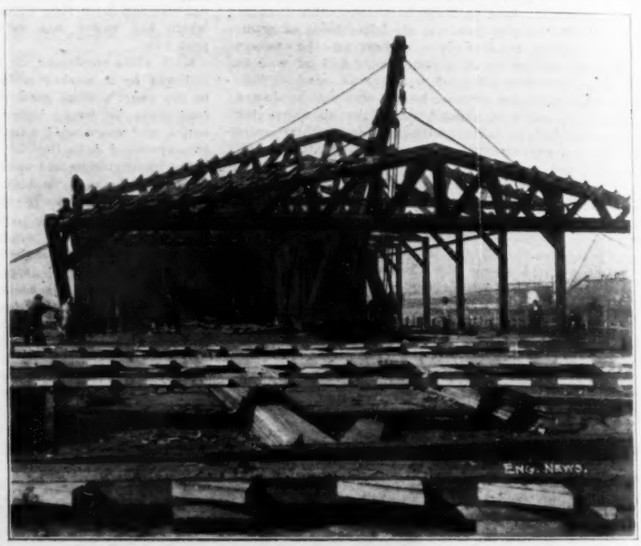
RAPID ERECTION OF PIER SHED FRAME, DELAWARE, LACKAWANNA & WESTERN R. R.

Unusually rapid work was recently accomplished in erecting the framework of two pier sheds for the Delaware, Lackawanna & Western R. R. at Hoboken, N. J. The work referred to comprises two parallel sheds, each 1,700 ft. long, with depressed tracks between. The sheds are located on timber pile piers and are of wooden frame construction, the covering being corrugated iron. As a measure of protection against fire each shed is divided transversely by three concrete fire walls. The pier is wide enough to give external platforms to the sheds, and in these platforms are openings for ramps leading to horizontal folding side doors. The rapid erection work spoken of refers only to the timber framework.

As shown in the illustrations, the framework consists of simple roof trusses carried on end posts, or wall columns, and connected by wall stringers and purlins. All the truss and end port bents were framed and assembled complete before erection was begun. The wall stringers and purlins were also framed ready to be assembled with the bents. The next step was to lay the bents flat on the pier with the feet of the posts on the spots they were to occupy when set upright, the wall stringers were also laid on the pier floor alongside the positions they were to occupy. The accompanying views show this lay-out quite clearly. When the lay-out was completed as shown erection began.

A locomotive crane was run out on a track extending longitudinally of the shed at the center. This crane picked up the first bent and tilted it upright where it was shoved in position. As the bent was fitted two men standing in the knee braces at the corners rode up on it and remained. The second bent was then tilted up with two other passengers, and shored. The crane then cast loose and picked up the wall stringers, swinging them into position to be connected up by the men who had ridden up on the bents. As soon as the stringers had been placed the crane backed up so that its lowered boom, when swung to one side, would pass under the erected truss; it then advanced to the position for tilting up a third bent, which was connected up like the second. The two pairs of top men alternated in riding the bents. In fact the position and duty of each workman and the maneuvers of the crane were regulated with military precision. To this was due largely the rapidity of the work. The average time from attaching the crane ropes to one truss to attaching them to the next following was 15 minutes, and in some cases this time was less than five minutes. In the case of the second shed erected, the whole 1,700 ft. of bents were placed in between 16 to 20 working hours. The two sheds were erected at different times and the plan described was conceived by Mr. J. E. Snell, Superintendent of Buildings and Docks, Delaware, Lackawanna & Western R. R., and afterwards used by Mr. Henry Steers in erecting the second shed.





METHOD OF ERECTING PIER SHED FRAMEWORK WITH LOCOMOTIVE CRANE, DELAWARE, LACKAWANNA & WESTERN R. R.

FIREPROOF CONSTRUCTION THE ONLY METHOD OF REDUCING THE NATION'S ENORMOUS FIRE LOSS.*

By Alcide Chausee.†

This North America of ours is vast indeed, our natural resources are great, and we have grown to look upon them as inexhaustible. With ruthless abandon we have devastated our forests; we have worked our lands beyond endurance, our mines, our fields are handled without regard for the morrow. Within but a few years our economists have called our attention to this useless waste, and indeed we find ourselves already confronted by a scarcity of certain commodities hitherto thought unlimited. People are just beginning to awaken to the true condition of things.

But of all the useless wastes that we, as a people, have indulged in, in the United States and in Canada, that of fire is the most inane, and in fact criminal, for by it property is not only devastated but lives by thousands are yearly sacrificed.

Think of it! In 1904 7,000 people were burned, an average of 19 fatalities through fire every day in the year, and a record that nearly equals that of all the railroad accidents of the United States and Canada countries, generally considered the most fruitful source by far of fatal accidents. And the record of 1904 was not an extraordinary one, the increase in deaths by fire has been growing steadily. Our present ratio is about nine lives lost by fire every year for every 100,000 of population. In 1900 the ratio was eight, and in 1890 it was five. Unless something drastic be done, what will be the ratio in 1950?

If the loss of life is appalling, the loss of property is disgusting. One hates to think that he is part and parcel of such a race of stupids. Not even China and Japan, with their paper and bamboo houses, submit to such a tax as we do. Our fire losses are equal to a tax of $25 per year per family, and that tax shows but the loss of property actually consumed. We have burned up one thousand million dollars worth in six years. Most losses, so called, are really but exchanges; one product turned into some other form; a loss perhaps to many, but a gain to some. Not so with fire—that loss is final, absolute, and the visual one is actual. The only gain to any one is an indirect one to the insurance companies who profit just so much more by the added anxiety after a fire that people have to be insured, and the insurance business is not run upon strictly philanthropic lines. The result of the transformation caused by fire is nothing but smoke—$230,000,000 worth of smoke last year. As with last year's death record the property loss does not show a spasmodic increase or something very extraordinary and unlikely to happen again. Even including the Baltimore fire it was but little over the regular increase, a record that has been climbing ever upward—a record that hovered about the 60 million figure in the '70's, the 100 million in the '80's, and one that has not been u[illegible] 160 million limit since 1900.

And, mark you, that is the destruction of p[illegible]. Along with that we throw away $150,000,000 a[illegible]ditional in maintaining and perfecting water pla[illegible] fire departments, salves to assuage the pain of [illegible], not a cure for the malady. Then, on top of that [illegible] to work and gamble with the fire insurance [illegible] and pay out countless millions more, so that they [illegible]imburse us individually should we suffer a loss [illegible]h fire.

For every dollar that the individual loser r[illegible] indemnity, the community has paid out three d[illegible]s insurance premiums. That is the average. I [illegible]n mind one city that has paid out in a given time $[illegible]00 in premiums, and that has gotten back $107,000 [illegible]s losses by fire during the same period. An int[illegible] speculation to be sure, but then, what gambling [illegible]n telligent?

But, leaving aside the accessories so to speak, a[illegible] restricting ourselves to the actual destruction of pro[illegible]y, the $230,000,000 of last year means a daily average of $630,000. Now, large as that is, we were satisfied [illegible]me time ago that it did not tell all the story. We draw [illegible]se facts from the fire department records, insurance reports, etc., more or less fallible sources of information, and that are far from being all-comprehending. We were sure that there were hundreds of fires unreported in interior districts of uninsured property, and where there were no fire departments. So, early in February of this year the Society of Building Commissioners and Inspectors prepared a most elaborate system, albeit expensive, to get all the facts concerning fire for at least a short period. The system was in working order by February 19, and was, I am sure, perfect on the 23d.

During the ten days of the test, from Feb. 19 to 28, there were 1,315 fires, totalling a loss of $14,809,000, or one and a half million dollars a day. True, it so happened that there were some pretty severe fires during that period, but, who tells us that there will not be as severe, or more severe ones later on during the year as there were previous to that time?

Granted that a record of a million and a half a day will not obtain the year round, and assuming indeed that we will not actually average more than half the amount, still the figure is exceedingly near the mark reached by the new buildings we are daily erecting and that give such a semblance of progress. At the most liberal estimate we build but a million dollars' worth of buildings a day, hence we are destroying perilously near as much as we are creating. Talk of race suicide!

New York averages 8,700 fires a year, Chicago 4,100. We burn up three theaters, three public halls, twelve churches, ten schools, two hospitals, two asylums, two colleges, six apartment houses, three department stores, two jails, twenty-six hotels, one hundred and forty flat houses, and nearly sixteen hundred homes every week of the year. We may say that every person who lives or has business in buildings is more or less exposed to danger by fire, owing to our recklessness or criminal carelessness or ignorance, but setting aside such broad terms we have estimates that there are 36,000 lives daily in danger, that is, there are that many people directly exposed to fire—people who escape from burning buildings—lives that are in imminent peril. No war, however bloody, shows any such average of lives daily exposed to destruction.

*A paper presented at the Annual Convention of the American Society of Municipal Improvements.

†Architect and Municipal Building Inspector, Montreal, P. Q., Vice-President, International Society of Building Inspectors.

And what is being done to prevent this terrible loss? A little—almost hopelessly little in the way of prevention, but much as a palliative. We throw water upon our fires (we are constantly endeavoring to throw it more effectually), and expect the next fire to burn less fiercely because thereof. In San Francisco, for instance, where little being done comparatively to improve the standard of construction. It is notoriously a wooden city, yet insurance rates are fairly low, because, forsooth, the fire department is so excellent. That is like extolling the advantages of a certain locality as a health resort. It may be miasmatic, yellow fever may stalk amuck; its houses and streets may be foul, but, glory be, its doctors are skilful!

So far as cure goes, note how little we have done. In this broad land there are but three thousand buildings that can be called "fireproof," and that very largely only in their structural parts, that is, fireproof buildings like those in Baltimore, whose steel frames and terra cotta floors withstood the attack where all else about them, the stones, the marble, the wood, went the way of all things combustible or destructible.

What is the cure? But two things will tend toward the accomplishment of that end, and neither water supply nor fire department is one of them. The first thing to do is to surround our old and dangerous buildings with safeguards, to correct their worst faults where practicable, and to compel their demolition as soon as possible. The second is to absolutely bar the erection of combustible structures in the future.

Some would say that that would be a hardship upon the individual, for we have grown so accustomed to using wood that it seems to be a fixed mode of construction, sanctioned by time and custom, a sacred inheritance, any tampering with which must needs savor of sacrilege. Therein the folly.

There was a time when wood construction was true economy, indeed the only thing available. To-day, wood is almost a luxury. Lumber has gone up so much in price (over 150% in the last few years), while the fireproof materials, brick, steel, fireproofing tile, cement, etc., have been cheapened in cost of manufacture. There is absolutely no economy in building even a simple cottage of wood. Granted that the first cost in the fireproof material is 10% more than wood, but consider the wear and tear, the maintenance, the insurance and all those incidentals, and your frame cottage will have cost you in twenty years' time 30% more than a well-built non-inflammable structure would have done.

The deterioration in the value of a well built fireproof building, fire resisting in its finish and decoration, is but one-ninth of 1% a year, while that of the ordinary wood joists and stud partition affair is nearly 4% a year. Besides such improved construction has a host of other advantages. Sound proof, vermin proof, warmer in winter and cooler in summer, and in every respect superior to the old way of building.

Some weak hearted ones would have us believe that to bring about those two conditions would involve superhuman effort, well-nigh an impossibility. But our cities have accomplished other reforms quite as revolutionary, so thought at the time, as this would seem to be. The people sometimes chafe at what they term the restraint of individual liberty, involved in the enforcement of drastic curative laws. But not for long. North American intelligence is such as to soon recognize the value of perhaps individual sacrifice involved in a great public benefit. We may not hope, however, to bring the desired conditions about by mild persuasion, preaching. It will take vigorous action, and the only action that will accomplish anything is the adoption of most stringent building regulatons, and their strict enforcement by competent executive officers.

Building in general terms requires the clearest definition and restriction, while every class of building calls for a thoughtful and comprehensve special legislation. If we think that theater builders ought to enjoy certain latitude, we have but to scan the record of the Iroquois theater. If it be suggested that dock sheds are hardly worthy of special legislation, think of what happened at New Orleans. If wholesale warehouses be deemed unimportant, note what happened in Toronto. And so it is with every class of building. Nothing can be deemed unimportant, for that very building or class of buildings may prove the ruin of half your city.

Strict building regulations, I say, are all important and supremely necessary. Two hundred and sixty-four of our American and Canadian cities have realized that, for there either have been or are being adopted perfected building regulations in that many cities. One hundred and sixteen cities or considerable towns heretofore unprovided with a special building officer or department have the creation of such office under consideration. There are happy indices of betterment, however we may look, thank Heaven, but it is just such societies as this, made up of thinking, public spirited men, zealous in the upbuilding of their several municipalities that can do a world of good in facilitating this work, and bringing its consummation about even in our own times.

Of all the cities that have given most thought and earnest work to this matter Cleveland easily takes the lead. Her building ordinance may be said to be the combined work of nearly all the building experts in the country. A vast sum was spent upon its preparation, every item was discussed by experts, and its effect upon the legal side of the question as well as the technical were carefully weighed by specialists, and the society of which I am an officer, the International Society of Building Commissioners and Inspectors, has virtually advocated that ordinance in toto as its model and standard, and is urging every city in both countries to adopt it also with as little change as possible.

Some may think it verbose. It is complete, and leaves nothing to the misinterpretation or misjudgment of a perhaps too lax officer. Every point is covered.

I submit, and you will readily appreciate, that it would be a tremendous advantage to have a uniform code throughout both countries. As it is now one city will permit of a certain thickness of brick walls to carry a certain height of stories; a city fifteen miles distant therefrom insists upon an entirely different standard. So it is with allowable strains in framing, etc. The building business of all the cities is so closely related that this everlasting difference is not only confusing but leads to endless discussion and trouble. A hundred other considerations should compel us to advocate not only good building regulations, but uniform ones, and I sincerely trust that each one of you gentlemen will not only advocate in his own city the necessity of wise and strict requirements, but that he will go a step farther and strongly urge the Council, or whatever power is in charge of that branch of municipal service, to adopt the code that is most worthy of being made standard, and that has already been engrossed upon the laws of so many of the cities of these United States and Canada.

ANNUAL CONVENTION OF THE ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.

The 23d annual meeting of the Association was held at the International Hotel, Niagara Falls, N. Y., on Sept. 12, 13 and 14, and was somewhat disappointing in the attendance and also in the very meager discussion of the various reports and papers. Although the association has a membership of over 400, only about 30 members were present, and the attendance of the sessions averaged only about 20 to 25. It was voted that next year the meeting should be held in November, when the roadmasters' heavy work is done and when a larger attendance may be hoped for, although in former years the September meetings have been well attended.

At the opening session on the morning of Sept. 12, a brief address of welcome was delivered by the mayor, Mr. O. W. Cutler; and the presidential address (also very brief) by Mr. C. F. Blue. At the afternoon session, two committee reports were taken up.

HAND CARS.

This report dealt with the construction, use and repair of hand cars, and its most important point was the recommendation that there should be an inspector or repairman of hand cars to travel over a certain district and make all light repairs. The section foremen are not as a rule fitted to do this work, but if the cars are sent to the shop for repair, there is apt to be considerable delay, and the gang cannot work to advantage until the car is returned. It is desirable to keep cars out of the shop as much as possible, and also to make the roadway department independent of the mechanical department, and for that reason it is convenient and economical to have a special man to make repairs on the cars while they are in the hands of the section gangs. The plan was commended by several speakers.

UNLOADING, DISTRIBUTING AND LAYING RAIL AND TIES.

This was not properly a report, but a series of a few letters describing individual practice and opinions. It was followed by a rather diverse discussion upon various points suggested by the reading of these letters, the most important being the methods of handling rails. The rail handling machines now coming into use, and operated on the work trains, are very important in enabling the work to be done with better speed and economy. As to unloading heavy rails from gondola cars, Mr. Foley remarked that when rails are delivered in such cars he finds it economical to transfer them onto flat cars before sending them out to be distributed along the road. For this he uses a steam derrick car at the yards. He also thought it better to relay rails in strings, previously spliced and laid on the ties, than to put in a single rail at a time. In the latter case the men are crowded together and cannot work to advantage. The string of new rails is set close to the old rails, so as not to bend the splice bars when throwing the new rails into place.

TIES OF WOOD, METAL AND CONCRETE.—

This brief report was the only report presented at the morning session of the second day, and was a conservative review of the tie situation. In this country the wooden tie is still universally used, although there is an increase in the use of preservative processes. The experiments with steel and concrete ties are too limited and of too short duration to allow of any definite conclusions. In Europe, also, wood is more generally used than any other material, and the use of preservative processes is much more general than the use of substitutes for wood. Many failures and disappointments must be expected before anything definite results from experiments with metal and concrete ties. In this country, much more care should be taken in the selection of proper timber, and in the cutting and seasoning of ties, the drainage of ballast, etc.

Mr. Buhrer (L. S. & M. S. Ry.) precipitated a sharp discussion on tie-plates, by exhibiting pieces of ties from which flanged tie-plates had been removed, showing badly decayed timber under the plate while elsewhere it was sound. He claimed that this was due to water working under the plate and into the grooves formed by the flanges of the plate. He preferred the use of flat plates, as extensively used at switches, but some members thought these would be too noisy. If the plates are thick enough and heavy enough not to bend under the traffic (which bending would raise the end of the plate and its flanges and allow water to enter), and if they are thoroughly bedded on good ties, there should be little chance of trouble on this score. Unfortunately, the plates are not infrequently applied to decayed ties, or are not uniformly supported, or are not driven home upon the face of the tie, and if the plates then give trouble all the blame is liable to be placed upon them, although they are not responsible for the trouble. The plates are intended to give rails a good support and to protect the wood of the tie from being cut or worn by the rail.

SWITCHES, TURNOUTS AND SWITCH PROTECTION.

This paper by Mr. E. E. R. Tratman (Associate Editor of Engineering News), was presented at the morning session on Sept. 14. It gave a review of modern practice in switch and turnout construction, with examples of the practice on a dozen leading railways.

SWITCHES.—The length of switch rails is usually 15 ft. (or 16½ ft. with 33-ft. rails), but sometimes 18 ft., and as high as 20, 24 and even 30 ft. for connections of double track to single track or four track where trains run at high speed. These rails are now very frequently reinforced by flat bars or angle or tee irons riveted to the web. The throw of switch is from 3½ to 5½ ins. A few roads use a switch-point lock, consisting of a bar under the rails with lugs which hold the flanges of the switch and stock rails; this is interlocked with the switchstand. The present tendency is to use only one or two switch tie-rods, and to have these rods adjustable. At switches turning out from sharp curves (4° and over), the point of the switch rail on the outer or high side of the main track is sometimes set ahead of that on the low side, and a guard rail is placed close in front of the latter. The guard rail is 6 to 8 ft. long, with a flangeway of 1¾ ins. Of ten railways reporting, seven use rigid switchstands and three use automatic stands. The height of target at main line switchstands ranges from 5 ft. 6 ins. to 8 ft. for ordinary stands and from 12 to 18 ft. for high stands, some roads using semaphores instead of targets for these latter.

FROGS.—In regular practice a No. 10 frog is as sharp as should be used in main track, giving a turnout curve of 6°. This is the standard on many roads, and the maximum is usually No. 6, with a curve of 16° to 19°. On some roads the standard is No. 15 or No. 20 for high speed turnouts and for crossovers on double track, while Nos. 12, 15, 18 and 20 are generally used at the ends of double track. The bolted frog seems to be most generally used, and on lines of heavy traffic both bolted and clamped frogs are now generally reinforced with a base plate. The spring rail frog is almost universally used where the traffic on the siding is light as compared with the main track; frog substitutes, giving a continuous rail for both main track and siding are used to some extent, and include the Wharton, MacPherson and Coughlin devices. Frog guard rails should always be bolted or clamped to the track rails; some roads use light rails with base plates or chairs to give the required height, while on some high-speed electric roads the guard rail is ⅜-in. above the top of the guard rail in order to catch the back of the wheel where it is vertical (above the curve of the flange).

One of the most important improvements in frog construction is the use of cast blocks of manganese steel or liner plates of nickel steel to take the wear; in some designs the hard steel is used only to line the wing rails, but in others the frog point is also of manganese steel. Reports from several railways indicate that they outlast five to ten ordinary frogs (or in one case even 17 ordinary frogs of 85 lb. rails), but their high cost makes them economical only where the traffic is very heavy. Where ordinary frogs last only from three to six months, manganese-steel frogs have lasted for four and five years.

SWITCH PROTECTION.—On single track, all switches are facing switches for half the trains, but on double track it is possible to arrange nearly every switch as a trailing switch, though this is not always done until a serious facing-switch accident has called attention to the matter. Of ten roads reporting, from 2% to 40% of the switches on double track are facing switches. Accidents due to misplaced switches average five per month, the trains being sometimes derailed on the turnout curve or colliding with other trains on the sidings. The automatic block system provides against such accidents by displaying a danger signal while a switch is open. But this system is in use on only a small proportion of the railway mileage, and there are thousands of miles of line where switches have no fastening beyond a padlock and chain, and no device for warning an engineman except a target at the switch.

Distant signals connected with the switches can be applied, and are being used on a number of railways, but only to a limited extent. All the frog, switch and signal companies have mechanical or electrical devices for this purpose. It may of course be said the connections may be tampered with, but this would throw the signal to danger unless the signal (¼ mile distant) was also tampered with. Experience shows that malicious or mischievous persons will rarely take this trouble, but find their opportunity with an unprotected switch where the lock can be readily opened or broken and the switch thrown. The practice of a few roads as to switch signals is given below:

Atchison, Topeka & Santa Fe Ry.—Some switches are protected by signals 1,000 ft. distant, controlled electrically by switch boxes, sometimes with the addition of a track circuit. The apparatus is made by the Union Switch & Signal Co.

Buffalo, Rochester & Pittsburg Ry.—All facing point switches on double track are protected by semaphore distant signals; also switches on single track where the switch target is obscure and where trains run fast. The signal is 1,500 ft. distant, operated by wires from a separate switchstand interlocked with the switch with a double-wire lead-out. This apparatus is made by the General Railway Signal Co.

Baltimore & Ohio Ry.—Some switches are protected by signals 1,300 ft. distant, operated by wires. These are installed by the signal department.

Chesapeake & Ohio Ry.—In some cases wire-connected signals are used, 1,300 ft. from the switch, and operated from a double ground-lever switchstand. The apparatus is made by the General Railway Signal Co.

Chicago, Burlington & Quincy Ry.—Many of the switches are protected by distant signals, mechanically operated, averaging 1,500 ft. from the switch.

Chicago, Milwaukee & St. Paul Ry.—On important lines all switches in obscure locations are connected with semaphores 300 to 1,200 ft. from the switch.

Pennsylvania Lines.—Distant switch signals are put up wherever facing point switches are hidden from view, whether in single or double track. A few of these are automatic electric three-position signals, invented by Mr. G. B. Gray, of the signal department, and these will doubtless be used exclusively in the future. They are 3,000 to 4,000 ft. from the switches, and are operated by the breaking of a contact at the switch points.

RAILWAY TRACK CONSTRUCTION.

There were two papers dealing with this general subject. The first, by Mr. W. M. Camp, gave a historical review of track construction and development, modern improvements, and the problems involved in future development, including specially the great increase in the weight of modern locomotives. The work of the association in its relation to these matters was also reviewed. The next paper was by Mr. A. Morrison, and formed a supplement to that by Mr. Camp, as it dealt specially with track suitable for the present rolling equipment and traffic conditions. More regard must be given to the avoidance of grade crossings, and to the proper compensation of curves and the connection of grades by vertical curves. For ballast, there should be a bottom course of large stone, but the ties should be bedded in an upper course of smaller stone. The ties should be creosoted, at least 7 ins. thick, and fitted with tie-plates. Better and heavier rails are required, and more substantial rail joints; angle bars alone are not sufficient for first-class track. There was no discussion on either of these papers.

RAIL JOINTS.

This committee report stated that while angle bars 18 to 48 ins. long have been used, the best angle-bar joint is a supported six-bolt joint with bars 36 ins. long, slotted for spikes at each end but not in the middle. The committee, however, favored the girder type of joint (with splice bars having stiffening webs projecting below the rail), the bars to be 26 ins. long with four bolts ⅞-in. or 1-in. diameter.

The angle bar having a base plate, either separate or integral, has, to a large extent, superseded the ordinary angle bar joint. The detached base support, however, proved defective, mainly for the reason that as soon as one of the joint ties became loose the base-plate dropped just at the time when its assistance was most needed. The integral base-plate corrects this defect perfectly. There are several designs of this class of joint, all of which are an improvement over the ordinary angle bar. These joints increase the carrying capacity over the angle bar, though to a limited extent.

During the last ten years the traffic conditions and wheel loads, particularly on the Eastern trunk lines, has become so great that what is known as the girder joint has been extensively used. Girder joints having a positive base support have not proved a success, being too rigid under the rail ends, and the support acting as an anvil, causing damage to rail ends by either battering or splitting. The girder joints in successful service have free dependent flanges, the proper form, however, of these flanges seems to be yet undecided as there is quite a variance in the different designs.

TRACK SURFACE AND LINE.

This was a somewhat lengthy report, and some extracts are given below:

The roadbed should be so built up that the shoulders will be wide enough to permit of the proper sloping of the ballast and prevent the same from rolling down the embankment or into the ditch. On the other hand, the shoulders should be low enough to permit the free drainage of the ballast, being lower than the sub-grade itself so that the ballast will drain freely. The bottom of the ditches should be from 2 ft. to 3 ft. below the bottom of the tie, depending upon the nature of the soil. If the track is badly out of line it had better be given a general lining before attempting to do any surfacing. All short kinks should be lined out. All short swings should likewise be attended to. Long easy swings, although they may be unsightly, will detract very little from the riding merits of the track, and may be made less noticeable by running them out at the summit of a grade, or by adjusting them so as to be absorbed by a regular curve. Track that is generally out of gage or wide at joints, should be gaged ahead of the surfacing. At least two men should be sent ahead to do this work. Surfacing should be commenced at one end of the section, preferably at the end farthest from headquarters and should be continued through to the other end. Regular surfacing should be done by the section gang, as there is a possibility of training these men to tamp alike. Extra gangs nearly always perform this work in an indifferent manner, as the very nature of an extra gang makes it impossible to get uniform results.

Transitions or easements should be used on all curves from 1° upward and, where the speed exceeds 60 miles per hour, on all curves from 30 minutes up. Transitions should also be used between curves of different degree in the same way as they are used between tangents and curves. Use any transition curve of the type of the Searles, Crandall, the Holbrook spiral, or the cubic parabola, which may be run in by deflection or offset. The length of transition should be the same as the distance in which the curve elevation is run out. The superelevation of curves should be zero at point of spiral and increase to full elevation at end of spiral or beginning of a simple curve.

Since the elevation required is a function of, and depends upon the speed of trains, this speed is the first element to be determined. In general as a matter of safety the preference should be given to the fast passenger trains. Ordinarily an elevation of 7 ins. will not be exceeded, and speed of trains should be regulated to conform to this elevation. Where the freight traffic predominates and passenger trains do not ordinarily exceed a speed of 40 miles per hour, an elevation of ¾-in. per degree may be used; maximum elevation not to exceed 5 ins. On ordinary roads, handling a mixed traffic and where passenger trains do not exceed a speed of 50 miles per hour, an elevation of 1 in. per degree probably will be a good compromise; maximum elevation not to exceed 5 or 6 ins. Where fast passenger service is a specialty and the speed of such passenger trains ranges from 50 to 75 miles per hour, an elevation of from 1½ ins. to 2½ ins. per degree may be necessary according to the varying conditions; maximum elevation not exceeding 7 ins. No set rules can be laid down for the elevation of the outer rail on curves, as local condition, traffic, grades, etc., all have a bearing on the matter.

Permanent witnesses should be placed at points of tangents, points of spiral, points of simple curve and points of change of curvature; each witness should also indicate the amount of elevation at that point. Center stakes should be maintained on all curves and they should not be more than 25 ft. apart on transitions, nor more than 50 ft. apart on simple curves. Center stakes should be checked and missing stakes replaced every year if possible.

It is often difficult to maintain gage on curves, in such cases it is best to resort to the use of tie plates. When properly placed and of sufficient weight, they will maintain gage under the most severe tests and do not injure the ties by excessive spiking as is the case with rail braces. Gage on curves should not be widened unless absolutely necessary; and then should be limited to accommodate the engines with the longest rigid base; the other engines will take care of themselves.

There is a difference in opinion as to when widening shall begin, ranging all the way from 4° to 10°. For general practice we would recommend ¼-in. on curves from 3° to 5°; on curves from 5 to 10°, widen ¼-in.; from 10° to 15°, widen ½-in.; from 15 to 20°, widen ¾-in.; over 20°, widen 1-in., this being the maximum. When it is decided a practice to widen gage on curve, it should not be done by gangs at work; each gang should be equipped with special gage properly adjusted to give the extra width. Where it is a practice to widen gage on curves in main tracks where switches and frogs are located, the space between the main rail and the guard rail must be made not much wider as the width of the gage has been increased. Wherever possible, standard gage should be maintained on all main track frogs and the gage should never be widened unless for a frog located in a curve where it becomes absolutely necessary to widen the gage.

As this was the last paper there was very little discussion. Mr. Morrison thought that 7 ins. was not sufficient maximum elevation on curves, he had had to provide for a speed of 65 miles an hour on 8° curves, and had gone as high as 10 ins. elevation. Mr. Buhrer and others thought that high speeds should not be permitted on sharp curves and enginemen reported for disobedience of this rule. It is taking too many chances of accident to run trains in that way. Another point is that the very fast trains are few in number as compared with ordinary fast trains and the general average of traffic; so that if the sharp curves are elevated for the excessive speed they will seriously affect the movement of the bulk of the traffic.

OFFICES AND PLACE OF MEETING.—The election of officers resulted as follows: President, C. Buhrer (L. S. & M. S. Ry.), Sandusky, O.; Vice-Presidents, W. E. Emery (C. & N. W. Ry.) and W. A. Brandt (L. S. & M. S. Ry.); Secretary and Treasurer, C. E. Jones (C. B. & Q. Ry.), Beardstown, Ill. As press of work at this season is often pleaded by members as an excuse for non-attendance it was voted to hold the meetings later in the year, and the next convention will be held at Chicago in November, 1906.

EXCURSIONS AND ENTERTAINMENTS.—Tickets to the various points of attraction at the Falls were furnished by the entertainment committee, and there were special excursions through the gorge and to the Ramapo Iron Works, Niagara Falls Power Co., etc. A reception and dance were given at the Cataract House one night, and the next night there was an entertainment and "cake walk," after which the party (by special permission of the Park Commissioners) went over to Goat Island to view the Falls by moonlight. Some notes of the exhibits are given in another column.

METHOD AND COST OF CONCRETING JEROME PARK RESERVOIR, NEW YORK CITY.

By Halbert P. Gillette,* M. Am. Soc. C. E.

The work to be described relates to the lining of 250 acres of reservoir basins with concrete. About one-third of the concreting is now done, covering nearly all the "west basin" of Jerome Park Reservoir. On this job there are 18 Ransome concrete mixers, each served by a gang of 20 men, and the area covered daily by these 18 mixers is approximately 1½ acres, when all are working under favorable conditions.

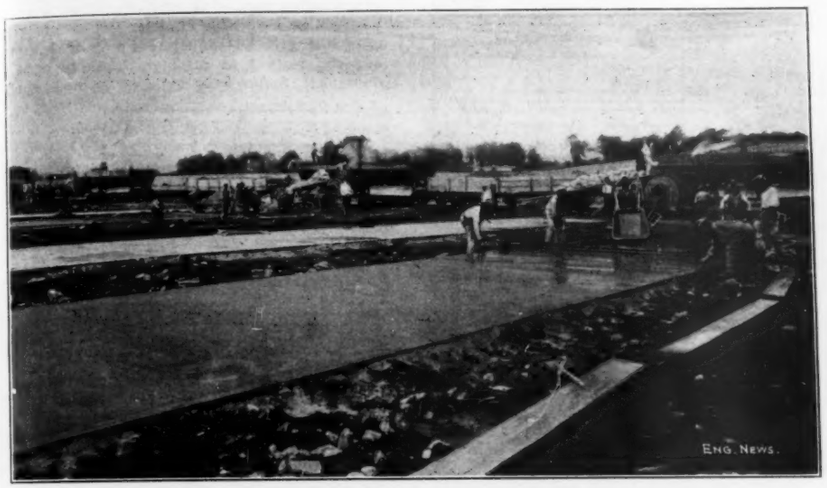
The stone for the concrete is hauled to the mixers in flat cars, tracks for this purpose being laid in parallel lines about 150 to 200 ft. apart, lengthwise of the reservoir. The sand and cement are delivered in wagons.

The accompanying photograph shows one of the mixers and the manner of feeding it. The stone it will be seen, is shoveled from the car by four men, the men shoveling directly into a charging hopper provided with a gate. The sand is delivered from the small stock pile at the foot of the runway, the barrows being also dumped into the hopper. While the machine is mixing one batch of concrete, the charging hopper is being loaded with the next batch. As soon as one batch has

*Consulting Engineer, 1120-1121 Park Row Building, New York City.

discharged from the mixer, the gate of the charging hopper is opened, and the materials for the next batch run by gravity into the mixer.

It will be noted that the concrete mixer is mounted on a low four-wheeled truck, enabling the machine to be quickly moved from one location to another. It will also be seen that the boiler supplying steam to the engine driving the mixer is not mounted on the same truck, as is commonly done. In view of the large number of mixers operated on this contract, it has been found cheaper to remove the small boilers from the trucks, and supply the steam for several mixers from one large boiler, steam pipe lines being run from the one boiler to three or four mixers.



LAYING THE CONCRETE FLOOR IN THE JEROME PARK RESERVOIR; NEW YORK WATER SUPPLY.

The contractor has adopted the ingenious expedient of using his locomotives for furnishing the steam for the mixer engines. This enables the whole mixing plant to be quickly shifted from place to place. Furthermore, it distributes the wages of one fireman over several mixers. The steam pipes are not covered in any way. This is perhaps a mistake, for, by using suitable pipe covering, the fuel bill could be lessened and a greater number of mixers could be served by one boiler.

The view of the work shows how the concrete is laid in long alternate strips, 16 ft. wide and 6 ins. thick, extending from track to track. In the foreground will be seen two wooden "forms," between which the concrete is laid. These "forms" serve to guide the pick-and-shovel men in getting to exact grade, and they serve also to assist in leveling the concrete surface, as will be described.

To deliver the concrete from the mixers, wheelbarrows are used, a gang of six barrow-men to each mixer. Two men spread the concrete as it is dumped from these barrows, and two more men level it off carefully and "float" the surface with a long, straight edge spanning the 16-ft. concrete strip and resting on the "forms." The concrete is mixed quite wet but not sloppy and by working the straight edge back and forth over its surface, an excellent finish is secured. Indeed, it would be hard to name a job of similar character that presents so fine an appearance. Not only is the surface very smooth immediately after laying, but it remains so.

Coming now to a brief discussion of economics, we shall see that excellent as is the plant and the general arrangement for doing the work, some improvements are nevertheless possible.

The following is the size of the gang and the daily wages paid for operating each mixer:

		Per 10 hrs.
4 men shoveling stone into hopper..	at $1.50	$6.00
2 men delivering sand in barrows...	1.50	3.00
2 men delivering cement.....	1.50	3.00
1 man dumping mixer.....	1.50	1.50
1 man tending engine and water....		2.00
6 men wheeling concrete in barrows	1.50	9.00
2 men spreading concrete.....	1.50	3.00
2 men leveling concrete.....	1.50	3.00
1 foreman		3.00
Total per day.....		$33.50

This does not include the fraction of a day's wages of a locomotive fireman, nor the cost of fuel. The writer timed the output of a number of these gangs and found that a half-yard batch of concrete every 5 mins. was averaged. This is equivalent to 120 batches or 60 cu. yds. in 10 hrs. Inspectors of the work stated that 60 cu. yds. were easily averaged, and that as high as 90 cu. yds. had been mixed by one mixer in 10 hrs., with only four men shoveling stone.

However, due to the small number of men engaged in shoveling the broken stone, the output of each mixer is far below what it might readily be. The four stone shovelers really limit the output of concrete to their capacity as shovelers. When the rock is delivered in hopper-bottom cars, as it often is, the shovel must be forced into a resistant mass of stones, not easily displaced by the blade of a shovel. This takes time and energy—it reduces the output of each man. When, however, flat cars are used to deliver the stone, the men have a flat surface along which to slip the shovel blade underneath the stone, thus greatly facilitating the work. The writer has had men average 20 cu. yds. of broken stone loaded in 9 hrs. by each man shoveling from a flat surface, as compared with 15 cu. yds. loaded from a heap in a gondola car. Evidently, then, it does not pay to deliver stone in hopper-bottom cars, when the stone is to be shoveled out by hand. By using flat cars entirely, and with five good shovelers in a car, it would be a simple matter to increase the output of each mixer on this job.

Another important point in the economic operation of concrete mixers is the method used in conveying the concrete away from the mixer. On this job wheelbarrows are used, and it requires about 12 barrows to take away a half-yard batch of concrete. In other words, each barrow holds about 1 cu. ft. of concrete, or 150 lbs. This is a very small barrow load. As a matter of fact, on a level, clean, runway, a load of 300 lbs. is easily wheeled in a barrow. While the runways are level on this work, they are not clean—the concrete slops over the sides of the barrows. Using barrows with shallow bowls loaded with wet concrete, it is impossible to prevent spilling. It would be wise, therefore, to substitute two-wheeled push carts for conveying the concrete, such as were used by the Ransome & Smith Co. in the construction of the Foster-Armstrong piano factory.* These carts hold 6 cu. ft. and are pushed by one man, where a level plank runway is laid. They do not spill their contents, and the runways remain clean, which greatly reduces the rolling resistance. But that is not all. By the use of such carts, a batch of concrete is discharged from the mixer in much less time than where wheelbarrows are used. For example, the writer found, by timing the work at Jerome Park Reservoir, that, when a string of wheelbarrows is in line, it takes about 7 secs. to fill each barrow. As a rule, however, slight delays occur, and if 10 secs. are averaged in loading each barrow, the men are doing well. With 12 barrows per batch, we have 120 secs., or 2 mins., required to discharge each batch. There is probably no type of concrete mixer that discharges a number of small barrow loads with greater rapidity than the Ransome mixer, due to the fact that the mixer itself is not tilted to discharge. Nevertheless, we have at least 2 mins. consumed in loading 12 barrows. When the mixer discharged uninterruptedly into a large bucket or skip, the writer found that only 15 or 20 secs. were required to discharge a batch. Note the difference. We now see one reason why it pays to use a larger conveyor than a wheelbarrow in moving concrete from a mixer. With a concrete cart holding 6 cu. ft., two, or at most three, loads would carry away a small batch, and the time to empty a mixer would be reduced proportionately.

A question that is repeatedly asked by contractors is: "How many yards of concrete will this mixer turn out in a day?" The answer should be: "With a good mixer, the output will depend upon your methods of conveying the materials to and from the mixer." Nowhere has the writer seen a better answer to this question than on two particular contracts, one of which is this work at Jerome Park Reservoir, and the other at the Spiers Falls dam (described in Engineering News, June 18, 1903). It happens that in both cases Ransome mixers of the same size were used. But at Spiers Falls, the materials were delivered from bins by gravity directly into the mixers, and from the mixers into large buckets on cars. There the writer timed a large number of 23 cu. ft. batches, which averaged 2 mins. each, the concrete being thoroughly mixed. We have just seen that it took 5 mins. per batch on the Jerome Park Reservoir work, and that each batch was smaller—½ cu. yd.

At Spiers Falls, the mixers were charges from overhead bins, so that their daily output was not limited by the number of men engaged in handling the stone and sand. Nor was the output limited by the method of transporting the concrete from the mixers, for the concrete was discharged into large dump buckets that were hauled off on cars. All that did limit the output was the amount of mixing deemed necessary by the inspector. This is an item that varies with the inspector. The writer looks to see the time come when engineers will specify concrete much leaner in cement than is now the fashion. To make up for the smaller quantity of cement, engineers will require longer mixing of the concrete ingredients. No matter what the make of the mixer, the greater the number of turns that the materials receive in the mixer, the stronger the resulting concrete. This last statement has an economic qualification, and it will be the province of the engineer to discover the point at which it ceases to pay to give more turns to the concrete. Machine-mixed concrete is being specified where a few years ago hand-mixed concrete would have been deemed good enough. The next logical step is to specify a minimum number of minutes that the concrete must be mixed, and to increase this minimum where lean concrete is used.

The division engineer in charge of the Jerome Park Reservoir construction is Mr. F. S. Cook. The concrete work is being done under a subcontract by Mr. William Bradley.

*Described in Engineering News, Sept. 7, 1905.

A MUNICIPAL ELECTRIC LIGHTING PLANT FOR Columbus, O., was put in operation early in the present year. It is located on the grounds of the West Side pumping station and cost about $500,000. It has a capacity of 2,000 arc lamps of 2,000 c. p. each and its generators are operated by steam turbines. According to statements made by Mr. Julian Griggs, M. Am. Soc. C. E., City Engineer of Columbus, O., in a paper read on Sept. 12 before a number of associations at Columbus, this plant has reduced the cost of lighting, as compared with private ownership, from $74.50 per lamp per year, the lowest contract price for moonlight schedule, to $60 for an all-night schedule; this includes interest on plant at 4% and depreciation at 8%, as noted in recent reports by a committee composed of citizens and appointed by members of the city council.

CEMENT AND CONCRETE TESTS AT THE ST. LOUIS EXPOSITION.

By Richard L. Humphrey, M. Am. Soc. C. E.*

Great Expositions mark the progress made in the industrial world, and emphasize the advance in particular lines. The Louisiana Purchase Exposition was no exception. Those who were fortunate in being able to attend the Exposition at Chicago in 1893 and St. Louis in 1904 doubtless observed the progress which had been made in the branches in which they were especially interested. To those interested in cement, a very noticeable feature of the former was the absence of an American Portland Cement Exhibit and the elaborate German exhibits of this material. This was naturally to be expected at a period when American Portland cement was hardly known and was regarded as of doubtful quality, while German Portland cement was universally used and was held in very high regard. The total consumption of Portland cement in 1903 was 3,264,801 barrels, of which 82% was of foreign and only 18% of domestic manufacture. In the decade which has since elapsed a great change has taken place in the production and consumption of American Portland cement. The production has increased 450%, while the importations have fallen off about 73%; the consumption now exceeds 26,505,881 barrels, and this country has grown from one of the smallest to one of the largest Portland cement producing countries.

It was quite appropriate that this remarkable growth of the cement industry in America should be fittingly exploited at St. Louis, and it was natural that this exploitation should be made by the American Portland cement manufacturers in a collective exhibit. Such an exhibit formed the gateway to the mining gulch of the Exposition and was one of the most attractive of the outside individual exhibits. The fact that there were no foreign cement exhibits worthy of note served to emphasize the withdrawal of the foreign Portland cement from the American market, resulting from the development of the American Portland cement industry. In yet another particular was this collective exhibit noticeable. In 1893 the American Portland cement manufacturer, while not openly hostile to the inspection and testing of his product, was nevertheless not a strong advocate and frequently rebelled against the restrictions placed on him by the testing engineer. Yet it was because of this continual raising of requirements which compelled the manufacturer to improve his product, that he occupies a premier position in the cement industry to-day. We now find the manufacturer no longer the opponent but the firm advocate of [illegible] methods for testing. This new attitude was [illegible] in the equipment and operation of the [illegible] Testing Laboratory in which was exploited the methods for testing cement proposed [illegible] special committee of the American Society of Civil Engineers, whose report was distributed gratuitously. Only those who had an active part in the erection of buildings and installation of exhibits at a great Exposition can appreciate the vexatious delays occasioned by unforeseen difficulties; this was particularly true of the cement exhibit.

It was originally intended that the work of construction should be carried on during the Exposition as a working exhibit. To secure greater advantages in an educational way it was subsequently decided to complete it as soon as possible, but before this could be accomplished the Exposition was well towards its close. The buildings, and the installation of the equipment of the laboratory and of the other exhibits were quickly completed and the whole placed in a working condition. As the collective Portland cement exhibit and model testing laboratory have already been described, this article will be confined to a description of the results of the tests which were made.

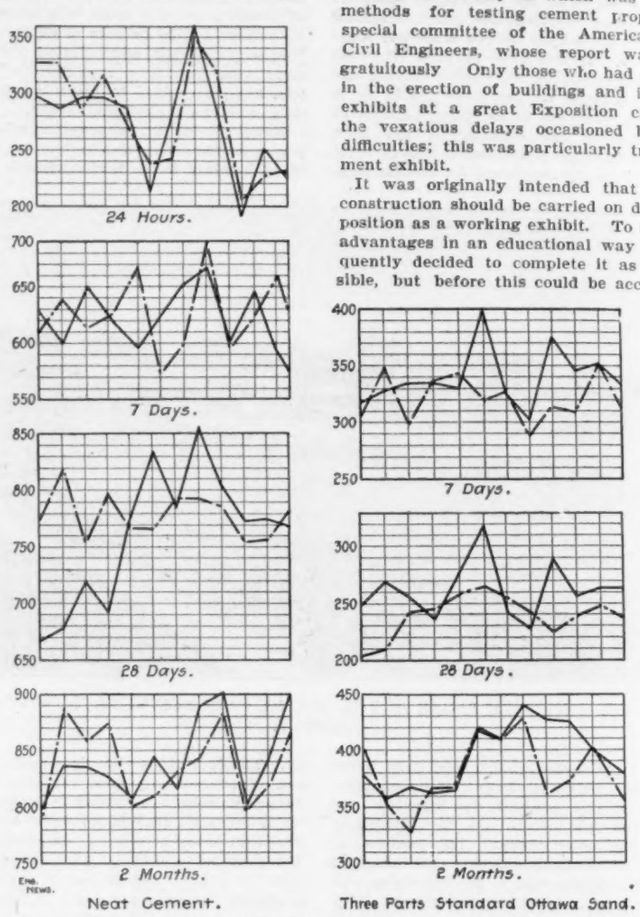


FIG. 1. DIAGRAMS OF RESULTS OF TESTS OF CEMENTS AND MORTARS, SHOWING EFFECT OF "PERSONAL EQUATION."

The limited time available after the completion of the exhibit was insufficient for the execution of any elaborate series of investigations. It became necessary, therefore, to concentrate the work on such tests as would be productive of data of the greatest value. The tests made were of two kinds: those made in the laboratory and those made among the outside exhibits, consisting for the most part of full size concrete beams and floor slabs which were loaded to destruction with pig iron. The work in the laboratory was confined to illustrating proper methods for testing cement and to investigations of the comparative value of the various sands, gravels, and broken stone used in some of the principal cities of this country.

Inasmuch as the exhibit was the joint work of some forty Portland cement companies it was deemed undesirable to advertise any particular company either by permitting individual exhibits or by the use of a particular brand. The building, an excellent example of reinforced concrete construction, was built with cement which was a mixture of four brands of Portland cement, readily found in the St. Louis market. The same policy was followed in the cement used in the laboratory tests; in which case a thorough mixture was made of five brands, which gave a standard Portland cement of sufficient quantity for the entire series of tests.

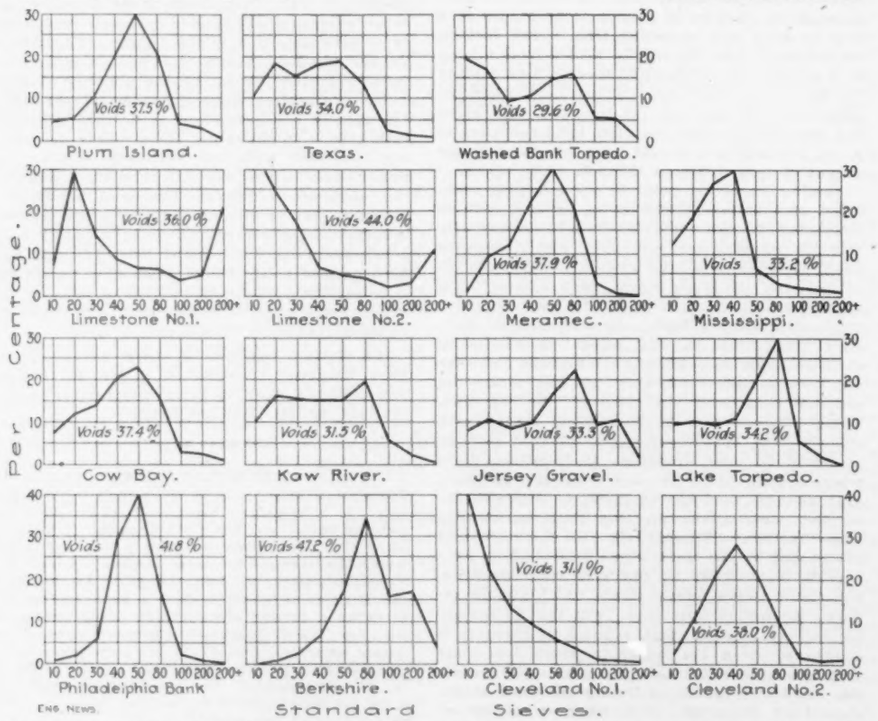


FIG. 2. DIAGRAMS SHOWING GRANULOMETRIC ANALYSIS OF VARIOUS SANDS FOR CEMENT MORTARS.

*Harrison Building, Philadelphia, Pa.

TABLE I.—Giving Results of Tests of Five Brands of American Portland Cement and of Samples Made from a Mixture of All Five Brands.

SAMPLE NUMBER	FINENESS IN PER CENT RESIDUE IN SIEVE NO. 100	FINENESS IN PER CENT RESIDUE IN SIEVE NO. 200	TIME OF SETTING IN MINUTES INITIAL	TIME OF SETTING IN MINUTES HARD	PER CENT WATER	TENSILE STRENGTH POUNDS PER SQUARE INCH NEAT 1 DAY	NEAT 1 DAY AVERAGE	NEAT 7 DAYS	NEAT 7 DAYS AVERAGE	NEAT 28 DAYS	NEAT 28 DAYS AVERAGE	SAND 7 DAYS	SAND 7 DAYS AVERAGE	SAND 28 DAYS	SAND 28 DAYS AVERAGE
A	9.88-	24.99-	279-	510-	19½	112 101 117	116	582 547 530	553	670 694 782	715	155 190 170	169	232 260 255	249
A	9.15	25.40	284	484	19½	142 109 123	133	529 579 465	524	680 730 670	700	165 180 126	147	277 298 263	279
B	8.80-	25.91-	99-	110-	20¼	230 208 220	220	591 602 615	603	790 756 778	776	287 266 270	274	427 423 396	415
B	9.00	24.85	62	120	20¼	238 272 250	250	641 650 649	647	743 721 727	730	259 293 244	265	387 345 380	387
C	11.90	29.48	269-	495-	20.0	112 107 110	110	631 626 590	616	838 874 797	836	237 267 230	245	382 372 422	392
C	10.00	26.30	215	495	20.0	125 130 139	131	676 644 604	641	852 865 904	874	190 191 226	202	345 358 362	355
D	8.99-	24.30	40-	171-	20¼	218 247 231	232	576 622 580	593	673 721 778	724	260 274 260	271	345 381 374	367
D	8.40	26.56	45	185	20¼	246 239 250	250	572 670 585	576	695 727 678	700	262 253 265	260	413 343 320	375
E	4.69-	22.93	35-	265-	20¼	192 196 196	196	542 545 597	561	610 670 631	644	220 211 208	213	317 335 349	333
E	4.10	21.50	37	280	20¼	220 221 226	222	520 574 530	541	640 673 671	661	170 217 187	191	310 291 290	297
AVERAGE	9.04	25.34	135	248	20¼		179	583		740		234		358	
AVERAGE	8.19	25.39	149	290	20¼		196	580		738		213		337	
STANDARD CEMENT	7.79	24.85	190	314	20.0		274	621		741		248		371	
	7.75	25.60	151	332	20.0		280	623		779		246		368	

It is a rather curious fact, that the average of the tests of the mixture of the five brands was higher than the average of the tests of the individual brands. The result of these tests is summarized in Table I. The variations in the results of these tests are due to two causes: (1) Changes in the quality of the cement due to atmospheric conditions, and (2) changes occasioned by the variation in the "personal equation" of the operator. Two men made the same tests simultaneously, using similar apparatus and methods. The effect of the "personal equation" and other changes is set forth in the diagrams Fig. 1; the ordinates being the successive tests as made, practically at daily intervals. These men were inexperienced in the beginning and it will be noted in the diagram that while the results were far apart in the beginning they became more concordant as experience was acquired.

In the comparative tests with the standard cement of sands, gravel, and broken stone it was only possible in the limited time to test those from the following points: Berkshire, Mass.; Cleveland, Ohio; Cowe Bay, Long Island, N. Y.; Chicago, Ill.; Dallas, Tex.; Kaw River, Iola, Kan.; Philadelphia, Pa.; Plum Island, Boston, Mass.; St. Louis, Mo.

The results of these tests will be found in Tables II, III, IV, and diagram Fig. 2. A study of the latter is quite interesting in that it shows the relation between the size of the particles and the percentage of voids. The tests seem to indicate that the smaller this percentage the greater is the strength of the mass; this percentage being dependent on the size of the particles. Where the particles are well graded from coarse to fine the percentage of voids is reduced to a minimum. This was found to be true of the unscreened sands and gravels, the highest results being obtained with the sand or gravel containing the least percentage of voids and showing the best gradation in the size of particles from coarse to fine.

When this material is screened to one size as 20-30 the per cent. of voids and the strength become practically the same, regardless of the strength previously obtained with the unscreened material. In this particular it apparently matters not what the geological origin of the material is, provided it is not undergoing further decomposition. It is also observable that the specific gravity of the sands and gravels is practically the same.

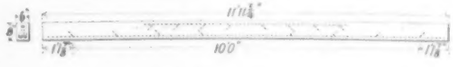
An examination of Table IV will show the very small percentage of fine material passing the number 200 sieve and even of material designated as "silt" except in the case of the two limestones. This fine material in all cases being inorganic and should not, therefore, be classed as "loam"—a term in common use. The term "loam" is a much abused one, is rarely ever used correctly, as "loam" properly so called is a vegetable mould and has a decided weakening effect on the strength of any material in which cement is used as a binder. Fine inorganic material, if not present in excessive proportion, enhances the strength of mortars or concretes, as it tends to lessen the percentage of voids thereby reducing the quantity of cement required to fill the voids.

In addition to the above tests, four experimental beams were tested in the laboratory; three of these (two of rectangular and one of T-section) were made according to the Hennebique system; and the other, also rectangular in section, according to the Kahn system. The beams of rectangular section were made under identical conditions and were designed to carry the same load using the same percentage of steel reinforcement. These beams were made in the open air and were not wetted after being made and the forms were removed just before the tests were made, at the end of 60 days. The beams remained in the open air during that time and were not moved until tested.

Test cubes were made of the concrete from which the beams were cast and the results of these tests may be found in Table V from 25 to 30, inclusive.

Fig. 3 shows the condition of the beams after testing; the photographs are not, however, sufficiently clear to show the location of the hair cracks. The poor quality of the concrete which will be alluded to later, caused the beams to fail without developing the full strength of the steel in tension, although in both the Hennebique and Kahn beams the compressive resistance of the top of the beam was materially increased by the steel reinforcement. In the latter beam the results would probably have been higher had the top reinforcing bar run the full length of the beam, as it will be observed that the concrete failed around the ends of this bar.

The following is the result of the tests of these beams in the order in which they were tested:



BEAM 1, KAHN SYSTEM.—Length over all, 11 ft. 11¼ ins.; clear span, 10 ft.; breadth, 6¼ ins.; depth over all, 8¼ ins.; depth to center of steel, 7¼ ins.; compressive strength concrete, 1,747 lbs. per sq. in.; weight of beam, 593 lbs.; mixture, 1:2:4; reinforcement in top, one ½-in. Kahn bar 9 ft. long; reinforcement in bottom, two ½-in. Kahn bars 11 ft. 11¼ ins. long.

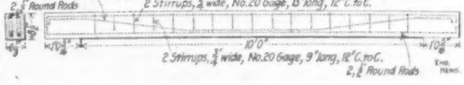
Steel in tension..... 1.50%
Steel in compression..... .80%

Total steel 2.30%

Loads. lbs.	Deflection. in.	Remarks.
1350	3/32	
2350	1/8	
3350	5/16	Crack appeared on right under end of top of reenforcing bar.
4350	3/8	
5350	15/32	Crack appeared on left under end of top of reenforcing bar.
6350	17/32	
7350	5/8	
7770	7/84	Failed by concrete crushing around ends of top reenforcing bar. Concrete buckled at the ends of top bar.
7830		

TABLE II.—Specific Gravity, Percentage of Voids and Granulometric Composition of Various Sands for Cement Mortar.

NAME	LOCATION	SPECIFIC GRAVITY	VOIDS	FINENESS IN PER CENT OF RESIDUE ON SIEVE NO. 10	NO. 20	NO. 30	NO. 40	NO. 50	NO. 80	NO. 100	NO. 200	PER CENT THRU NO. 200	PER CENT SILT	REMARKS
BERKSHIRE	BERKSHIRE MASS	2.64	42.2	0.0	1.0	2.5	6.5	17.4	34.5	16.1	17.1	4.4	1.3	WHITE
CLEVELAND #1	CLEVELAND OHIO	2.61	31.1	41.3	21.9	13.6	9.3	6.7	4.1	1.4	1.3	1.0	5.8	BROWN
CLEVELAND #2	" "	2.66	37.9	2.3	11.4	21.7	26.3	21.5	10.5	1.7	1.1	1.3	2.6	LIGHT BROWN
COW BAY	NEW YORK	2.67	37.4	7.5	11.9	13.9	20.6	23.1	16.0	2.8	2.6	1.3	3.6	" "
JERSEY GRAVEL	PHILADELPHIA	2.66	33.2	8.0	11.0	8.6	10.1	17.6	22.3	9.9	10.4	1.8	5.2	YELLOWISH
KAW RIVER	IOLA KANSAS	2.62	31.5	10.0	16.3	15.6	15.0	15.1	19.3	6.0	2.4	0.4	TRACE	LIGHT BROWN
LIME STONE #1	ST. LOUIS MO.	2.67	35.8	6.6	26.8	14.0	8.5	6.7	6.4	3.7	4.8	20.3	21.4	WHITE
LIME STONE #2	" " "	2.67	44.0	34.7	24.4	10.6	6.6	5.0	4.3	1.6	1.5	11.3	26.3	GREY
MERAMEC RIVER	" " "	2.59	37.9	0.9	9.2	11.8	22.6	30.1	20.8	3.9	0.6	0.1	48	LIGHT YELLOW
MISSISSIPPI RIVER	" " "	2.63	33.2	11.9	18.3	27.8	25.6	6.5	2.6	1.9	1.5	0.9	1.7	CHOCOLATE COLOR
PLUM ISLAND	BOSTON MASS.	2.66	37.5	4.5	5.6	10.8	20.2	30.7	20.6	3.8	3.0	0.7	3.8	YELLOWISH
TEXAS	DALLAS TEXAS	2.62	34.9	11.6	18.3	15.6	18.3	18.6	13.1	2.5	1.3	0.5	6.7	YELLOWISH BROWN
BANK WASHED TORPEDO	CHICAGO ILL.	2.67	29.6	19.5	16.8	9.5	10.6	14.6	15.6	6.4	5.6	1.2	3.5	" "
LAKE TORPEDO	" "	2.66	34.2	9.8	10.2	9.6	11.4	20.3	29.7	6.2	2.3	0.3	1.8	YELLOWISH
BANK SAND	PHILADELPHIA	2.64	41.8	0.9	1.9	6.1	30.1	40.4	17.1	2.3	0.9	0.3	1.9	BROWN
	AVERAGE	2.65	36.9	11.3	13.8	12.9	16.3	18.3	15.6	4.7	3.6	3.1	5.4	AVERAGE



BEAM 2, HENNEBIQUE SYSTEM.—Length over all, 12 ft. ⅝-in.; clear span, 10 ft.; breadth, 6¼ ins.; depth over all, 8½ ins.; depth to center of steel, 7½ ins.; weight of beam, 620 lbs.; mixture, 1:2:4; compressive strength of beam, 60 days, 1,747 lbs. per sq. in.

Steel in tension 1.60%
Steel in compression..... .80%

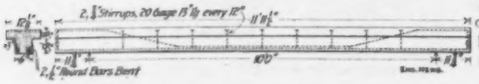
Total steel 2.40%

Loads. lbs.	Deflection. in.	Remarks.
1850	3/32	
2350	1/8	
4350	5/16	
5350	7/16	
6350	9/16	Hair cracks appeared on either side of center, very faint.
7650	13/16	
8150	15/16	Cracks became more general.
8450	1-13/16	Failed by concrete buckling in center of beam.

TABLE III.—COMPARATIVE TENSILE STRENGTHS OF MORTARS MADE OF SANDS OF THE COMPOSITION SHOWN IN TABLE II.

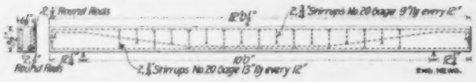
TENSILE STRENGTH IN LBS. PER SQUARE INCH

NAME	NEAT 1 DAY	NEAT 1 DAY AVERAGE	NEAT 7 DAYS	NEAT 7 DAYS AVERAGE	NEAT 28 DAYS	NEAT 28 DAYS AVERAGE	STANDARD OTTOWA SAND 1 MO.	STANDARD OTTOWA SAND 1 MO. AVERAGE	STANDARD OTTOWA SAND 7 DAYS	STANDARD OTTOWA SAND 7 DAYS AVERAGE	STANDARD OTTOWA SAND 28 DAYS	STANDARD OTTOWA SAND 28 DAYS AVERAGE	UNSCREENED SAND 1 MO.	UNSCREENED SAND 1 MO. AVERAGE	UNSCREENED SAND 7 DAYS	UNSCREENED SAND 7 DAYS AVERAGE	UNSCREENED SAND 28 DAYS	UNSCREENED SAND 28 DAYS AVERAGE	SAND SCREENED TO 20 - 30 2 MOS.	SAND SCREENED TO 20 - 30 2 MOS. AVERAGE	SAND SCREENED TO 20 - 30 7 DAYS	SAND SCREENED TO 20 - 30 7 DAYS AVERAGE	SAND SCREENED TO 20 - 30 28 DAYS	SAND SCREENED TO 20 - 30 28 DAYS AVERAGE
BERKSHIRE	128 131 111	117	536 636 665	612	768 772 770	770	696 914 906	839	738 880 884	834	1064 987 880	977	428 433 430	430	199 196 198	197	318 316 336	323	1169 1076 1071	1105	1141 1140 1130	1137	1387 1360 1310	1352
CLEVELAND #1	178 119	149	637 674 663	658	780 792 788	786	854 883 840	859	1011 1004 1000	1005	1240 1240 1240	1240	374	374	198 170 173	180	309 310 316	312	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
CLEVELAND #2	204 184	194	672 678 680	677	830 811 780	807	839 844 840	841	1000 1000 1000	1000	1240 1240 1240	1240	360	360	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
COW BAY	175 195	185	635 598 580	604	818 788 810	805	839 844 840	841	1000 1000 1000	1000	1240 1240 1240	1240	360	360	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
"	204 234	219	556 573 648	592	783 781 800	788	904 873 864	880	1015 1038 1030	1028	1240 1240 1240	1240	365	365	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
COW BAY	186 207	197	636 681 635	650	761 783 805	783	845 823 834	834	1040 1040 1040	1040	1240 1240 1240	1240	375	375	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
"	206 170	188	636 654 673	654	783 765 783	777	845 823 834	834	1040 1040 1040	1040	1240 1240 1240	1240	375	375	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
KAW RIVER	187 190	189	699 686 634	673	815 840 777	744	844 818 844	835	1040 1040 1040	1040	1240 1240 1240	1240	375	375	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
"	136 130	133	655 640 683	660	722 771 779	757	813 814 818	815	1040 1040 1040	1040	1240 1240 1240	1240	375	375	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
LIMESTONE #1																								
"																								
LIMESTONE #2																								
"																								
MERAMEC	182 186	184	594 599 671	621	670 775 650	698	839 840 825	834	1175 1161 1176	1170	1240 1240 1240	1240	380	380	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
MISSISSIPPI	223 223	223	693 693 681	689	832 806 810	816	904 880 717	867	1209 1206 1210	1208	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
"	205 193	199	693 610 611	638	764 680 717	687	765 807 792	788	1240 1240 1240	1240	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
PLUM ISLAND	209 247	228	583 571 665	606	730 783 784	766	863 705 784	784	1240 1240 1240	1240	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
"	178 206	192	672 646 646	655	768 835 793	799	768 831 814	804	1240 1240 1240	1240	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
"	141 145	143	591 570 630	597	723 795 834	784	816 844 831	830	1240 1240 1240	1240	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
TEXAS	195 190	193	642 678 654	658	783 780 781	781	798 806 780	795	1240 1240 1240	1240	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
"	205 206	199	616 675 673	651	783 730 783	765	784 778 793	784	1240 1240 1240	1240	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
WASHED BANK TORPEDO	169 178	174	593 644 649	629	776 778 773	776	840 871 806	839	1102 1179 1165	1149	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
LAKE TORPEDO	175 230	203	615 643 710	656	764 788 783	778	867 780 860	836	1142 1182 1161	1162	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
"	233 201	217	671 650 680	667	834 660 760	751	834 860 780	825	1240 1240 1240	1240	1240 1240 1240	1240	389	389	198 201 196	198	349 343 340	344	1153 1151 1150	1151	1141 1140 1130	1137	1387 1360 1310	1352
AVERAGES		174		631		781		841		1205		1237		389		198		344		1153		1137		1352
		184		633		776		840		1140		1230		388		198		343		1151		1136		1350
		177		623		770		846		1181		1230		389		198		343		1151		1136		1350
										1140		1237		388		198		343		1151		1136		1350



BEAM 3, HENNEBIQUE SYSTEM.—Length over all, 11 ft. 11½ ins.; clear span, 10 ft.; breadth, 12¼ ins.; depth over all, 9 ins.; depth to center of steel, 7½ ins.; weight of beam, 876 lbs.; mixture, 1:2:4; strength of beam, 60 days, 1,747 lbs. per sq. in.

Loads. lbs.	Deflection. in.	Remarks.
2350	1/8	
4350	5/32	
6350	3/8	
7950	15/32	First hair cracks appeared in center.
8350	9/16	
8750	7/8	Failed by concrete crushing at top in center of beam.



BEAM 4, HENNEBIQUE SYSTEM.—Length over all, 12 ft. ½-in.; clear span, 10 ft.; breadth, 6⅛ ins.; depth over all, 8½ ins.; depth to center steel, 7½ ins.; weight of beam, 614 lbs.; mixture, 1:2:4; compressive strength, 60 days, 1,747 lbs. per sq. in.

Steel in tension 1.60%
Steel in compression..... 80%
Total steel 2.40%

Loads. lbs.	Deflections. in.	Remarks.
1350	1/16	
2350	1/8	
3350	3/16	
4350	7/32	
5350	3/8	
6350	1/2	Faint hair cracks on either side, center very faint.
7350	19/32	
8350	13/16	
8050	1	Failure by concrete buckling at top in center.

In the space adjacent to the Exhibit building there had been planned an elaborate series of test beams built according to the various systems in use in this country. Unfortunately, the exhibit was completed so late that it was impossible to stir up sufficient interest to carry out an elaborate program. Besides, there were no funds available for such experiments, and the expenses connected with the test which were made were very generously borne by the Trussed Concrete Steel Co., of Detroit, Mich., and The Hennebique Construction Co., of New York, to whom the writer wishes to express his thorough appreciation and thanks for the interest taken and the assistance rendered by them in the experiments.

The tests in question consisted in reinforced concrete beams and floor slabs of 15 ft. span and a cantilever. Simultaneous with the making of the test beams 6-in. cubes were made from the concrete which was used in making the beam and floor slabs. These results of these tests are found in Table V.

The chatts which were used were a calcareous chert, all of which passed a No. 10 screen. There are two varieties of chatts, a hard silicious chert which comes from Joplin, Mo., and the soft calcareous chert which comes from Belle, Mo. This material is the refuse from the lead mines and as it is relatively cheap it is extensively used in St. Louis and vinicity. The chatts used was of the calcareous variety and were quite soft and friable, having a low compressive strength and therefore making a concrete correspondingly poor.

It was for this reason that the beams tested failed in many cases under a small load before the strength of the steel was developed.

It will be noted that the cinder concrete gave correspondingly low results. The cinder was clean and of a better quality than is generally used—although it contained a large quantity of unburned coal. The strength of the concrete in which it was used was about one-half of that of a good stone concrete. The modulus of elasticity was about 1,500,000 in the concrete made with chatts and 500,000 for the cinder concrete—values materially lower than are usually quoted.

These tests show how important it is to have a hard aggregate in order to secure a strong concrete. An important feature generally overlooked in tests of concrete is the compressive strength of the aggregate itself. If a test of the aggregate was made it would serve as a basis for comparing the compressive resistance of concrete and would indicate whether the difference was due to differences in the strength of the aggregate or was due to the mixing or to character of the other aggregates.

The concrete for the beams and floor slabs was mixed by hand in the proportion of one part Portland cement, two parts Mississippi River sand and four parts chatts; wooden forms were used and were thoroughly wetted before the sloppy wet concrete was deposited in them. The concrete was not subsequently wetted and the forms were removed at the end of ten days. They remained in air, unprotected and were not h[illegible] until tested at the end of about 60 days, they were loaded to destruction with pig [illegible] This method is a slow, laborious process r[illegible] ing the exercise of great care in loading so [illegible] maintain the centre of gravity of the load [illegible] the center of the beam, but there were no [illegible] means available for testing these beams of [illegible] large size and span.

The overturning which occurred in the ca[illegible] A and B was produced by the unequal com[illegible] sion of the earth under the bearings supp[illegible]

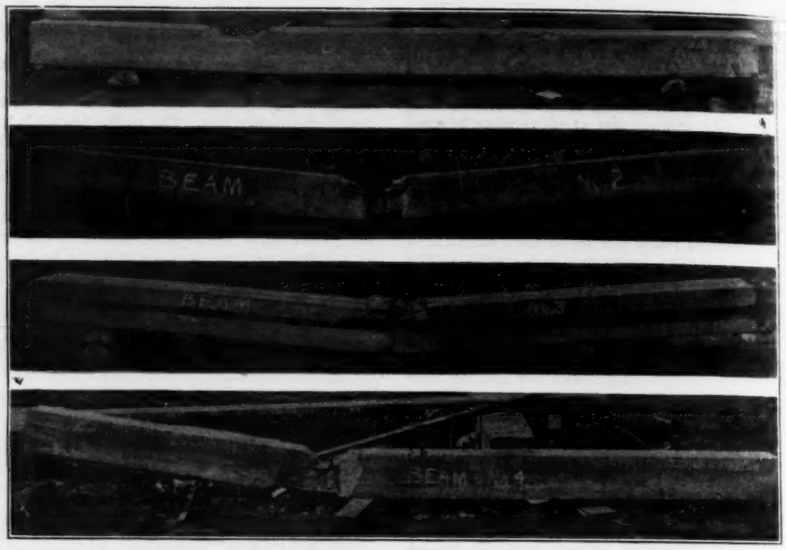


FIG. 3. VIEWS OF REINFORCED CONCRETE BEAMS 1, 2, 3 AND 4 AFTER FAILURE.

The beams. Possibly, this will also account for the shearing of the overhanging un-reinforced slab in the T beam F. The ground on which the beams were built had been filled in with the refuse staff, scaffolding, etc., from the exposition buildings and in proportioning the bearing area insufficient allowance was made for the compressibility of this filling.

In order to avoid arching of the pig iron, through the deflection of the beam under load, the pig iron was placed in piles and sufficient clearance was left between the piles so that the deflection would not bring them into contact. Where the load required to break the beam is large, these piles are quite high (for A and B they were 5 ft.), the piling of the pig becomes slower and the maintenance of the equilibrium much more difficult as the height increases. The rate of loading varied from 50 lbs. to 150 lbs. per minute. The deflections were measured at the center from a string stretched taut over two wire nails in the side of the beam immediately over the edge of the support and in the center line of the bottom reinforcing steel.

TABLE IV.—COMPARATIVE COMPRESSIVE STRENGTHS OF MORTARS MADE OF SANDS OF THE COMPOSITIONS SHOWN IN TABLE II.

NAME	COMPRESSIVE STRENGTH IN LBS. PER SQ. INCH — OTTOWA STANDARD									UNSCREENED									SCREENED TO 20-30								
	7 DAYS			28 DAYS			3 MONTHS			7 DAYS			28 DAYS			3 MONTHS			7 DAYS				28 DAYS				3 MONTHS			
BERKSHIRE	1415 1435 1340	1378		2436 2325 2377	2350		2375 2215 2344	2347		700 688 644	542		893 1000 932	913		1500 1345 1383	1506											
"	1325 1275 1250			2290 2293 2323			2378 2225 2320			388 390 389			980 838 874			1490 1476 1494												
CLEVELAND #1	1395 1380 1278	1307		2735 2653 2706	2778		3440 2488 3145	2867		1428 1473 1467	1241		1885 2035 1970	1679		3020 2521 2724	2572											
"	1350 1360 1255			1725 1775 1780			2795 2758 2835			1043 1388 1248			1425 1390 1385			2815 2478 2876												
CLEVELAND #2	1308 1355 1297	1311		2398 2336 2217	2171		3462 2680 3478	3482		926 935 932	1066		1678 1685 1673	1821		2850 2662 2767	2613		1198 1370 1189	1172		2300 2350 2275	2271		2428 2450 2464	2493	
"	1275 1378 1328			2688 2800 2764			2275 2389 2231			1200 1200 1200			1400 1380 1350			2453 2483 2468			1185 1125 1155			2300 2413 2307			2476 2565 2530		
COW BAY	2085 2705 2794	2037		3513 3725 3626	3185		4038 3975 4007	3787		2030 2175 2103	1632		2898 2634 2896	2547		3476 3390 3484	3137		1520 1530 1685	1544		2350 2378 2369	2428		2380 2363 2373	2373	
"	1325 1343 1294			2688 2800 2764			2450 3563 3507			1019 1303 1161			2413 2036 2236			2800 2778 2787			1473 1533 1503			2493 2485 2491			2828 2795 2813		
KAW RIVER	1500 1327 1262	1436		2128 2135 2131	2053		2540 2463 2502	2483		1495 1475 1485	1540		2463 2175 2319	2100		2415 2475 2445	2373		1300 1448 1374	1353		2363 2375 2369	2344		2410 2438 2424	2456	
"	1678 1508 1593			1920 2000 1775			2478 2420 2449			1525 1500 1512			1900 1863 1881			2283 2115 2251			1343 1300 1322			2578 2063 2361			2628 2445 2536		
LIMESTONE #1	1580 1355 1367	1389		2186 2178 2183	2219		2658 2520 2589	2419		2618 2420 2519	2587		2313 2493 2403	2466		2775 2633 2704	2704		1525 1478 1502	1377		2360 2370 2365	2188		2240 2400 2320	2287	
"	1430 1405 1412			2275 2285 2280			2895 2713 2804			2663 2400 2532			2238 2459 2349			2775 2613 2695			1213 1150 1182			2334 2185 2207			2178 2172 2176		
LIMESTONE #2										956 935 947	1005		1113 1188 1150	1813		1624 1672 1647	1702		1083 1083 1067	1095		1944 2226 2085	2056		2333 2093 2149	2108	
"										975 1130 1103			1275 1675 1475			1635 1670 1753			1113 1128 1121			2000 2055 2016			2063 2076 2069		
MERAMEC	1725 1625 1478	1369		2795 2883 2839	2765		3685 3575 3647	3469		1270 1370 1320	1280		2370 2915 2295	2017		2900 2363 2333	2345		1235 1288 1257	1241		2125 2000 2063	2138		2450 2478 2464	2450	
"	1280 1275 1240			2698 2663 2681			3300 3075 3188			1360 1150 1175			1770 1705 1738			2435 2298 2357			1380 1218 1224			2458 2370 2414			2435 2432 2435		
MISSISSIPPI	1185 1345 1186	1244		2723 2670 2697	3048		3788 3154 3502	3375		1563 1525 1544	1519		2803 2748 2776	2775		2875 4138 4006	4275		1084 1000 1042	1023		2410 2538 2474	2539		3363 3388 3376	3048	
"	1358 1250 1301			2313 2676 2494			3625 3150 3388			1498 1448 1473			3480 4125 3773			4675 4413 4544			980 1048 1008			2460 2748 2604			2713 2600 2657		
PLUM ISLAND	1368 1868 1468	1457		2475 2688 2581	2457		3045 3363 3154	2984		1154 1038 1096	1043		1635 1518 1577	1564		2780 2498 2639	2583		1308 1338 1323	1211		2353 2303 2327	2241		2715 2780 2828	2704	
"	1500 1400 1450			2388 2275 2331			2785 2735 2755			1013 966 991			1600 1500 1550			2533 2466 2601			1193 1208 1199			2463 2654 2554			2600 2556 2580		
TEXAS	1305 1340 1323	1118		2183 2310 2246	2176		3163 2834 2772	2788		1300 1333 1317	1444		1735 1938 1837	2250		2378 2463 2378	2699											
"	930 1045 1013			2092 1980 2002			2478 2670 2584			1600 1545 1624			3138 2350 2673			3588 3478 3466												
WASHED BANK TREFFEN	1495 1665 1134	1183		3320 2700 3040	2767		3980 2573 3727	3333		1413 1355 1384	1554		2603 2380 2447	2761		3158 3145 3151	3084		1113 1000 1057	1105		2350 2400 2330	2382		3410 2870 2990	2497	
" " "	1055 1380 1158			2313 2675 2494			3675 3750 3713			1723 1725 1724			3150 2600 2875			3150 2806 2978			1130 1135 1133			2350 2322 2336			2866 2840 2853		
JERSEY GRAVEL	1725 1645 1727	1431		2704 2484 2594	3103		3900 3488 3719	3579		1000 1143 1072	1052		1563 1643 1753	1636		2385 2418 2402	2315		1153 1178 1166	1148		2163 2260 2213	2169		2453 2488 2471	2397	
" " "	1200 1070 1135			2640 2675 2658			3075 3413 3244			955 1108 1032			1625 1363 1494			2304 2235 2269			1145 1115 1130			2075 2178 2126			2335 2335 2335		
PHILA BANK SAND	1180 1230 1205	1105		2498 2253 2467	2873		3780 2715 3734	3626		505 458 496	475		1038 1020 1029	900		1713 1775 1744	1629		700 556 655	577		1063 993 1028	1114		2038 2030 2037	2004	
" " "	1088 950 1019			2308 2338 2316			3440 2998 3219			450 455 453			778 763 771			1483 1543 1513			495 538 517			1190 1203 1197			1970 1968 1969	1937	
AVERAGE			1364			2331			2960			1284			2042			2607			1161			2171				2492

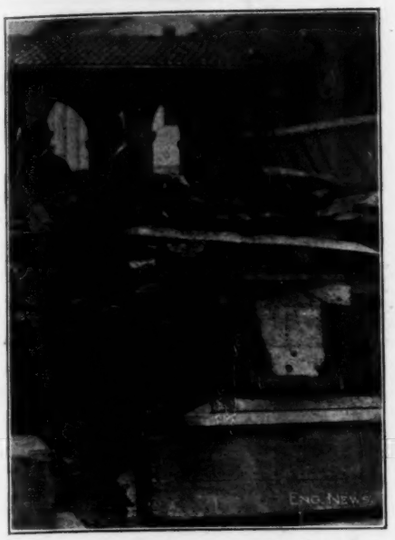


Fig. 4. View of End of Beam E Showing Shearing off of Slab and Sliding of Reinforcing Rods.

The following are the results of the tests of these beams:

BEAM F.—Built Sept. 13; tested Dec. 1, 1905. Length over all, 17 ft.; clear span, 15 ft.; breadth at base, 8 ins.; at top, 18 ins.; depth over all, 13½ ins.; depth to center of steel, 11½ ins.; reinforcement in bottom, two 1-in. round bars, with one 1-in. round bar just above; mixture, 1:2:4; weight of beam, 2,529 lbs.; compressive strength of concrete, 1,740 lbs. per sq. in.; per cent. of steel, 1.63; area of steel, 2.35 sq. ins.

Time.	Loads lbs.	Deflection. in.	Remarks.
10.50 A. M.	3656	3/16	
11.35 "	6877	3/16	
11.50 "	8997	1/4	
12.00 Noon.	10807		
1.05 P. M.	14105	7/16	
1.40 "	18898	9/16	Two hair cracks 1 ft. off center line, either side.
	20166		Failed.

TABLE V.—Results of Crushing Tests of Cubes Made from Concrete Used in Constructing Reinforced Beams.

SAMPLE NUMBER	AGE	PROPORTION	WEIGHT PER CU. FT.	AREA	COMPRESSIVE STRENGTH IN LBS. ULTIMATE	COMPRESSIVE STRENGTH IN LBS. PER SQ. IN.	REMARKS
1	60 DAYS		139.98	35.25	58500	1659	SLIGHTLY SPALLED AT EDGES
2		1 CEMENT	143.87	35.25	59910	1700	DO.
3		1 SAND	143.10	35.15	68500	1943	DO.
4		5 CHATTS	143.87	36.00	70350	1954	DO.
5			143.36	35.33	48000	1359	DO.
6			144.06	35.63	64250	1803	DO.
Ave			143.04	35.42	61585	1740	
7	DO.	1 CEMENT	143.18	35.84	29450	822	CORNERS SPALLED.
8		2 SAND	143.52	36.00	27210	759	
9		4 CHATTS	143.87	36.00	33450	929	
10			142.42	36.00	30900	858	
11			142.47	36.00	31125	865	
12			143.88	36.00	30500	848	
AVG.			143.44	35.97	30439	847	
13	DO.	1 CEMENT	146.70	34.76	30200	870	ONE CORNER SPALLED.
14		2 SAND	145.11	35.62	27880	783	
15		4 CHATTS	146.52	35.63	55250	1579	
16			147.62	36.00	49100	1364	
17			146.69	35.63	40700	1142	
18			145.75	36.00	35200	978	
AVG			146.23	35.61	39722	1119	
19	DO.		114.10	22.24	14550	654	VERY BADLY SPALLED TWO CORNERS
20		1 CEMENT	112.90	36.00	19050	530	
21		2 SAND	113.41	33.78	15900	471	VERY POROUS SPALLED ON EDGES OF FACES
22		4 CINDERS	112.73	35.90	22750	620	SPALLED SLIGHTLY AT EDGES.
23			113.20	33.25	19000	571	EDGES AND FACES SLIGHTLY SPALLED
24			118.72	36.00	19500	542	SLIGHTLY SPALLED
AVG			113.36	32.86	18458	565	
25	DO.		140.18	36.00	59400	1650	
26			139.97	35.20	50950	1450	
27		1 CEMENT	142.97	35.25	65650	1862	
28		2 SAND	141.80	35.25	74350	2052	
29		4 CHATTS	142.29	35.25	65250	1851	
30			140.33	36.00	598	1618	
AVG			141.10	3549	62810	1747	

Bars sliding as beam collapsed, Fig. 4. The slab sheared off on one side as will be seen, this was probably due to lack of uniformity of load. The bars did not slip until the beam collapsed. There was no reinforcing in the slab. The dimensions of beam and other information can be obtained from Fig. 5.

BEAM E.—Built Sept. 13; tested, Dec. 1, 1905. Length over all, 17 ft.; clear span, 15 ft.; breadth, 12 ins.; depth over all, 13½ ins.; depth to center of steel, 12 ins.; weight of beam, 2,677 lbs.; mixture, 1:2:4; compressive strength of concrete, 1,740 lbs. per sq. in.; reinforcement in bottom, three 1-in. round bars 17 ft. long; area of steel, 2.35 sq. ins.; per cent, 1.63.

Time.	Loads. lbs. sq. in.	Deflection. in.	Remarks.
9.00 A. M.	16510	9/32	Deflection not noticed before 1,000 lbs.
12.00 Noon.	20166	11/32	
	24612	15/32	
5.30	26460	1/2	
Dec. 2d.			
8.30 A. M.	33198	21/32	
8.30	26460	11/16	Two hair cracks, one on either side of the center line.
	33108		Failed.

A series of vertical cracks appeared until the beam failed suddenly by horizontal shear at one end entirely. Bars again slipped as beam collapsed. Dimensions of beam given in Fig. 5. Fig. 6 shows beam after failure.

BEAM D.—Built Sept. 13; tested Dec. 2, 3, 1905. Length over all, 17 ft.; clear span, 15 ft.; breadth, 12 ins.; depth over all, 13½ ins.; depth to center of steel, 12 ins.; weight of beam, 2,677 lbs.; mixture, 1:2:4; reinforcement in bottom, two ¾-in. Kahn bars 17 ft. long; reinforcement in bottom, one ¾-in. Kahn bar 9 ft. long, bent up slightly; area steel in tension, 2.34 sq. ins.; per cent. of steel, 1.63; compressive strength of concrete, 1,740 lbs. per sq. in.

Time.	Load. lbs.	Deflection. ins.	Remarks.
3.30 P. M.	6479	1/16	
3.50 "	8461	3/32	
5.00 "	11806	1/4	
5.30 "	15033	11/32	
8.30 A. M.	15033	11/16	
8.55 "	20732	3/8	
9.30 "	23476	1/2	
10.30 "	27800	11/16	
11.30 "	30719	1 in.	
11.45 "	32663	1¼ in.	
11.50 "	32663		Failed slowly 4 ft. 6 ins. from each end of beam.

For dimensions, etc., see Fig. 5.

BEAM C.—Built Sept. 12; tested Dec. 3, 4, 5, 1905. Length over all, 17 ft.; clear span, 15 ft.; breadth, 12 ins.; depth over all, 13½ ins.; depth to center of steel, 12 ins.; weight of beam, 2,677 lbs.; mixture, 1:2:4; reinforcement in bottom, two ¾-in. Kahn bars 17 ft. long; reinforcement in bottom, one ¾-in. Kahn bar 9 ft. long, bent up slightly; reinforcement in top, 2½-in. Kahn bars 9 ft. inverted; area of steel in tension, 2.34 sq. ins.; area of steel in compression, .76 sq. in.; total area of steel, 3.10 sq. ins.; per cent. of steel, 2.15; compressive strength of concrete, 1,740 lbs. per sq. in.

Time.	Load. lbs.	Deflection. ins.	Remarks.
Dec. 3.			
3.10 P. M.	5629	1/32	
3.50 "	11398	3/16	
4.20 "	15287	3/8	
Dec. 5.	Nothing done.		
Dec. 6.			
8.00 A. M.	15287	3/8	
8.30 "	18100	3/8	
9.00 "	21688	15/32	Hair cracks appearing.
9.30 "	24058	5/8	
9.55 "	26943	7/8	
10.05 "	28934	1	
10.10 "	29914	1¼	
10.15 "	30878	1 11/16	
10.25 "	.....		Failed.

Dimensions, etc., shown in Fig. 5.

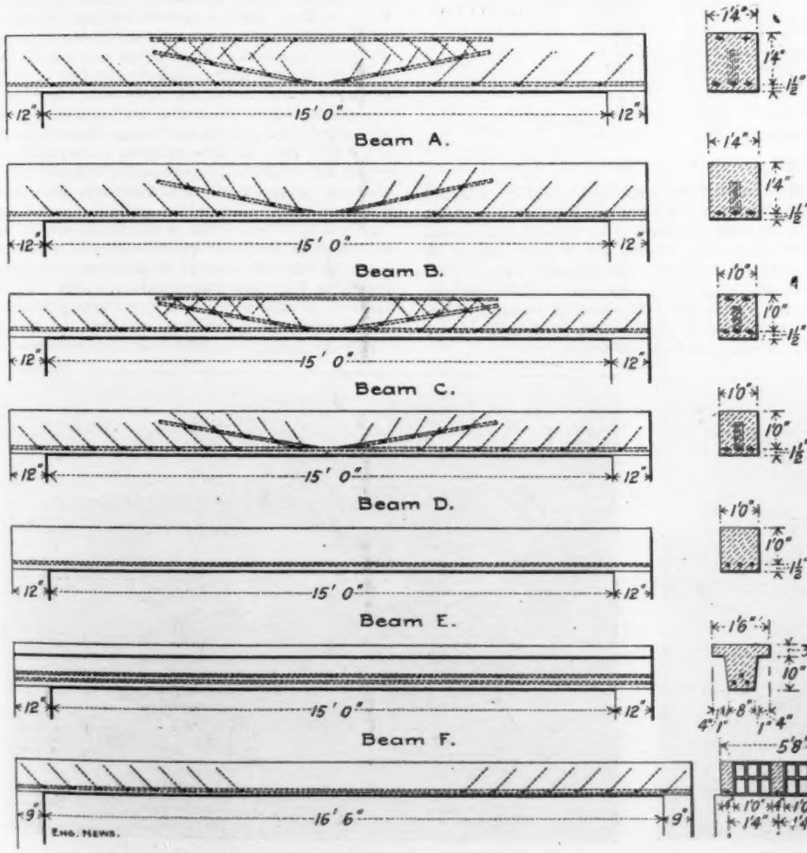


FIG. 5. DIAGRAMS OF TEST BEAMS AND FLOORS SHOWING DIMENSIONS AND REINFORCEMENT.

BEAM B.—Built Sept. 12; tested Dec. 5, 6, 1905. Length over all, 17 ft.; clear span, 15 ft.; breadth, 16 ins.; depth over all, 17½ ins.; depth to center of steel, 16 ins.; reinforcement in bottom, two 1-in. Kahn bars 17 ft. long; reinforcement in bottom, one ⅝-in. Kahn bar 9 ft. long, bent slightly upwards; area of steel, 3.62 sq. ins. or 1.41%; weight of beam, 4,600 lbs.; mixture, 1:2:4; compressive strength of concrete, 1,740 lbs. per sq. in.

Dec. 5:
Dec. 6:

Time.	Load. lbs.	Deflection. ins.	Remarks.
Dec. 5.			
2.00 P. M.	10417	1/16	
2.30 "	15189	3/32	
3.20 "	22802	7/32	
4.10 "	27607	9/32	
4.45 "	31487	11/32	One hair crack on bottom of beam under each bent bar.
Dec. 6.			
8.30 A. M.	31487	11/32	
9.35 "	33403	11/32	Two more hair cracks appeared.
10.50 "	38190	11/32	
12.45 P. M.	45082	15/32	
1.30 "	47817	3/4	Two more hair cracks appeared nearer bearings.
2.10 "	50000	7/8	
3.10 "	54735	1 11/32	
	55727	1 7/16	
	56712	1 19/32	
3.50 "	57696	1 11/16	
	58675	1 31/32	
4.15 "	59906	2	
5.00 "	60911	2 11/32	Beam overturned.

BEAM A.—Built Sept. 13, 1904; tested Dec. 7-14, 1905. Length over all, 17 ft.; clear span, 15 ft.; breadth, 16 ins.; depth over all, 17½ ins.; depth to center of steel, 16 ins.; reinforcement in bottom, two 1-in. Kahn bars 17 ft. lang; reinforcement in center, one ¾-in. Kahn bar 9 ft. long, bent up slightly; reinforcement in top, two ⅝-in. Kahn bars 9 ft. long, inverted; weight of beam, 4,600 lbs.; mixture, 1:2:4; area steel in tension, 3.62 or 1.41%; area steel in compression, 1.56 or .60%; total steel, 5.18 or 2.01%; compressive strength of concrete, 1,740 lbs. per sq. in.
Dec. 7:

Time.	Loads. lbs.	Deflection. in.	Remarks.
9.25 A. M.			Started.
10.45 "	10168	1/16	
11.40 "	15937	3/32	
2.25 P. M.	20769	5/32	
3.10 "	25632	3/16	
3.25 "	27617	3/16	
3.55 "	31548	3/16	
4.30 "	33561	3/16	
4.45 "	35477	7/32	
5.00 "	37458	7/32	Two faint hair cracks, one at each end of bent bar in center; beam started to overturn, bearings sinking unequally.

Dec. 8: Unloaded and straightened.
No deflection observable, then began loading.
Dec. 9:
Dec. 11:
Dec. 9:

8.30 A. M.	37458	7/32	
9.45 "	40839	7/32	
10.35 "	44723	1/4	Four hair cracks (2 more) on each side of center.
11.25 "	50000	5/16	Rain stopped, loading beam overturned, due to unequal settling of foundations.
	52963		

Dec. 11:

	52962	3/32	Set in beam.
	54945	13/32	
	60856	5/8	Beam overturned.

Foundations again settling unequally, beam straightened, one hair crack in center 2, 3 ft. 6 ins. on either side of center of beam; ⅝-in. deflection set in beam. Foundations releveled bearing area increased and beam reloaded.
Dec. 12: Sunday—Nothing done.
Dec 13:

11.15 A.M.	60856	3/8	Set in beam.

Fig. 6. View of End of Beam E Showing Sliding of Reinforcement.

Several hair cracks from top ¼-in. opening traveling off in both directions horizontally, middle each 8½ ins. from top.

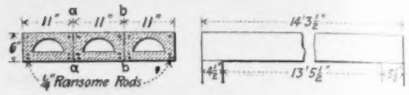
	63811	Two more hair cracks appeared on either side of center line.

Time.	Loads. lbs.	Deflection. in.	Remarks.
	66021	3/4	
3.45 P. M.	74941	1-1/8	
	75000		One crack 18 ins. from center line, 9 ins. from top. One crack 36 ins. from 11 ins. from One crack 56 ins. from 7 ins. from
5.00 P. M.	80000	1-3/8	
Dec. 14:			
8.00 A. M.	80000	1-3/4	
	81010	1-13/16	
	82005	1-13/16	
	83005	1-7/8	
	83977	1-7/8	
11.30 A. M.	85400	1-7/8	
12.00 Noon	87385	2-1/32	
1.25 P. M.	90362	2-5/8	
2.15 "	93269	3-1/8	
2.30 "	94074	3-5/16	
2.40 "	94512		Failed
Weight beam	4600		
Total load	99112		

KAHN SYSTEM HOLLOW TILE FLOOR CONSTRUCTION.—Built Sept. 21, tested Nov. 30, Dec. 1, 2, 1905. Length over all, 18 ftf. Clear span 16 ft. 6 ins. Width, 5ft. 8 ins. Depth, 10 ins. Tile, 10 × 12 ins. Beam joist, five, 4 × 10 ins., 18 ft. long, ¼-in. centers. Reinforcement, each joist, one ¾-in. Kahn bar, 18 ft. long. Mixture, 1:3:5. Area steel, each joist 0.78 in. or 2.30%. Weight of slab, 5,800-lbs.

Time	Loads. lbs.	Deflection. ins.	Remarks
Nov. 30:			
4.10 P. M.	12457	n. 3/32 s. 3/32	
4.45 "	18300	1/8 3/32	
5.10 "	22200	1/2, 3/8	Hair crack[illegible] center
5.30 "	25132	5/8 3/8	
Dec. 1:			
8.30 A. M.	25132	3/4 9/16	
5.30 "	25132	3/4 21/32	
Dec. 2:			
8.30 A. M.	25132	3/4 23/32	
11.25 "	25132	25/32 3/4	
11.50 "	34634	2-1/2	Two vertic[illegible] appeared [illegible] off centre [illegible] on either side.
11.55 A. M.	35611		Concrete com[illegible] to crush on top over last cracks loading stopped, beam kept cracking and slowly deflected until it failed at 12[illegible]20 minutes) with centre cracks opening up and another [illegible] ft. off centre line concrete at center crushing out and a crack running along line of steel from center to right three feet. Breaking load 500 lbs. per sq. foot. The dimensions of slab are shown in Fig. 5. Fig. 7 shows floor under load, Fig. 8 after failure.

SIEGWART FLOOR.—Length over all 17 ft. 3½ ins., clear span 13 ft. 5½ ins., depth 6 ins., width of slab 33 ins.



Time.	Load. lbs.	Deflection. in.	Remarks.
8.30 A. M.	2901	1/8	
9.15 "	5484	5/16	
9.25 "	8409	1/2	Hair cracks well distributed along bottom beam.
	10378	13/16	
	11366	7/8	
10.05 "	15313	1-23/32	
	16284	2-3/4	
10.15 "	16831		Failed.

This floor slab was composed of beams made according to Siegwart System; in above sketch the slab is seen to be composed of three slabs 11 × 6 ins. in section, and reinforced with rods according to Hennebique System without shear straps. The beams are cast around cores, core opening, shown in sketch, the steel being placed in position and the concrete cast around it; the cores are withdrawn and the beams feathered apart at the points indicated. These beams were made in New York, and were shipped by express when 60 days old to the exhibit, where they were placed in position and the joint grouted. A load of bags of sand was placed on the floor (100 lbs. per sq. ft.) and remained there until the close of the exposition when it was loaded with pig iron to destruction, the beams being about 6 months old. The idea of this system, is to make the beams for certain loads and spans and carry them in stock as steel I-beams are carried, shipping on order.

CANTILEVER.—This is shown in Fig. 9 and was built to illustrate the flexibility of reinforced concrete, the dimensions and reinforcement are shown in Fig. 10. The stairway hangs free and leads to the top which is a walk; this was in service during the exposition.

The cantilever was built, as was discovered af-

FIG. 7. VIEW OF KAHN HOLLOW TILE FLOOR UNDER LOAD.

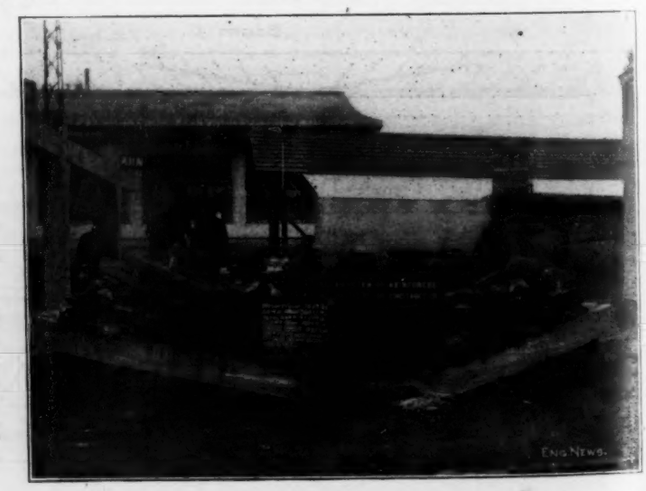


FIG. 8. VIEW OF KAHN HOLLOW TILE FLOOR AFTER FAILURE.

wards, over a wooden box drain and the settlement of the foundation caused the cantilever to tilt towards the outer end.

The forms, instead of being removed gradually, were quickly removed, and the sudden application of the load caused a strain which cracked the cantilever at the shank on the left-hand side. The props were restored and the cantilever washed with neat cement. The props were then gradually removed and the contilever remained unchanged until tested with pig iron. The application of this load caused the cracks to open at left side of shank and the cantilever collapsed. Fig. 9 shows the character of the reinforcement. As bars of the requisite size were not available a bundle of smaller rods was substituted; the shear members were insufficient to hold the cantilever and it pulled apart at the left shank and failed as shown in Fig. 11 before the compressive resistance of the concrete in the left centre section of the shank had been reached. The loading was as follows:

Loads. lbs.	Deflection. in.	Remarks.
3080	1/16	
9845	1/4	
13785	11/32	
14760		Hair crack appeared.
17680	1/8	Opening at center 11/16 in. at outer end.
20807		Failed 4-11/16 in. extension at the center.

Besides these, tests were made of cement shingles, concrete sewer pipe, cement bricks and hollow blocks.

The Collective Portland Cement Exhibit and Model Testing Laboratory was assembled with a view of exploiting the American Portland Cement Industry, and not with a view of advertising any particular process, plant or product. It was highly beneficial in disseminating a better knowledge of the proper methods of testing and of the nature, uses and properties of Portland cement; and in recognition of this fact it received a grand prize, the highest award of the exposition.

It is to be regretted that the time available for the experimental work was not longer, so that much more data could have been obtained.

It is, however, a matter of gratification to all those connected with this exhibit that the work thus started will be continued under the direction of the U. S. Government and other interested persons and it is to be hoped that the exhaustive series of investigations of structural materials which have been planned under the direction of the advisory board may be successfully carried out, thereby supplying information which will be of inestimable value to the engineering profession.

ANNUAL CONVENTION OF THE NEW ENGLAND WATER-WORKS ASSOCIATION.

Large attendance, a good and unusually well arranged and well executed program, and pleasant and instructive excursions to points of interest, characterized the twenty-fourth annual convention of the New England Water-Works Association at New York City, Sept. 13 to 16. The most notable feature of the convention was the discussion of the relation of copper sulphate to water supply. Quite as epoch-making, though of less general interest, was the paper on "Fire Service Meters."

REPORT OF THE COMMITTEE ON METER RATES.

A new basis for meter charges, or more properly, the addition to of the old flat rate meter charge of a foot frontage property assessment, was presented by the Committee on Meter Rates, Mr. Freeman C. Coffin, Chairman. The requirements of a meter system which shall be substantially just to all classes of consumers and at the same time as simple as possible, are:

(1) Sufficient revenue to meet all the wants of the works and, in the case of private ownership, to provide a profit.

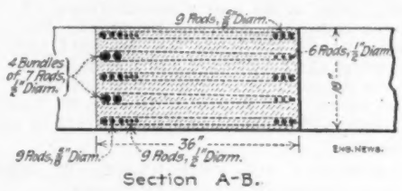
(2) Flexibility, so the rates may be raised or lowered to meet deficiencies or surplus of income.

(3) In houses with only one faucet the method should not increase the faucet or fixture rate, except in case of waste or excessive use. On the other hand, the method should secure from large well-plumbed houses enough revenue to meet a fixed charge, even if little water be used.

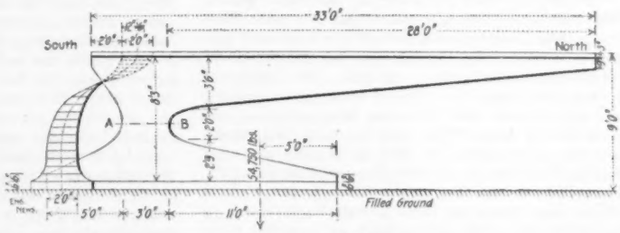
(4) It should be applicable to summer and winter resorts with their fluctuating populations.

(5) It should be adaptable to works with high fixed charges and low operating expenses, like gravity plants, or to the reverse conditions, like pumping and filtering plants. The method should meet the requirements of a "flat rate" without making the water rate too high for factories and other large users of water.

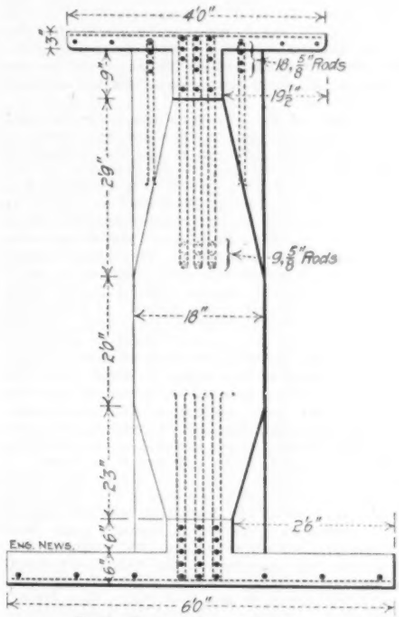
Two methods were considered. The first and "the most scientific method, and the one adapted for general and permanent use" is the assessment method; the second, which possesses the advantages of the fixture method in certainty of revenue where changes are being made from fixture to meter rates or where the works are new and small, is the multiple minimum rate method. Under the assessment method each piece of real property is assessed on a uniform frontage basis and in addition meter charges are made for all water used. Where the multiple minimum rate is adopted the consumer pays a given sum for each fixture. This entitles him to a stated amount of water, while for all water consumed above that amount stipulated meter rates are paid. To simplify accounts a few important fixtures may be taken for the multiple minimum charge. A total multiple minimum rate is also fixed, allowing the use of water for all purposes regardless of the kind and number of fixtures. The multiple minimum rate meets all but two of the five requirements already named, failing in



Section A-B.



Side Elevation.



End Elevation, North.

FIG. 10. ARRANGEMENT OF REINFORCEMENT IN CANTILEVER.

FIG. 9. VIEW OF REINFORCED CONCRETE CANTILEVER TESTED TO DESTRUCTION.

FIG. 11. VIEW SHOWING FAILURE OF REINFORCED CONCRETE CANTILEVER.

the case of flexibility and of providing a low rate for large users.*

As has been said, the committee considered the assessment basis as the most scientific of the two plans proposed. The argument for frontage assessments, as advanced in the report, is as follows:

There are certain expenses of a water-works system which must be met as long as the works are operated, which are affected but little, if at all, by the amount of water used. These expenses should be met by a revenue which is also independent of the amount of water used. The total amount of such expense is dependent more upon the length of the piping system than upon any other element of the plant. The amount of water used affects the capacity of the pumping plant, but not in direct proportion, and in many works not at all. The requirement for fire protection fixes the pumping capacity. The amount used affects the capacity of the supply, but not necessarily its distance from the center of distribution.

The frontage of the lot affects materially the total length of the piping system. Therefore there seems no other element which can serve so well and so justly as the measure of the constant yearly assessment as the length of frontage of the property. It is not material to the method how the frontage which shall be assessed is determined. It is probable that a municipality can assess all property, both that built upon, and vacant lots, while a company can only assess upon existing houses and their lots. It would seem to be fair that all buildings should be assessed, whether occupied or not. This, however, is not essential to the method. If vacant lots were not assessed, some limit to the amount of land to be assessed with each building would be necessary; for instance, each lot might be assessed upon a length not exceeding twice or three times the width facing the street, of the building upon it. A corner lot might be assessed upon one street only, or, as in the case of sewers, a certain frontage of the second street might be exempt. These details are not essential to the principle, and should be decided by the conditions of each case.

The exact proportion of the total annual expense of maintenance which should be assessed in this way is not essential. It seems to the committee, however, that it would be substantially just if, in ordinary cases, one-half of the total amount to be raised were assessed upon frontage and the balance raised by meter rates based upon the total consumption. The price per 100 cubic feet, or 1,000 gallons, in any place would then depend upon the total consumption. Taking the average place, it might be about 7½ cts. per 100 cu. ft., or 10 cts. per 1,000 gallons, based upon the water that would be measured through the meters.

In new works, or in those changing from fixture to meter rates, the probable revenue under the meter system is uncertain. The frontage assessment plan will give an assured income from the start. It also meets the other four stated requirements.

In conclusion, the committee expressed the following opinions: Water departments should purchase, own and repair meters; all public buildings, watering troughs, fountains, etc., should be metered, whether or not payment is made for the water delivered to them; gravity supply mains should be metered; a flat meter rate should be the rule; 100 cu. ft. rather than 1,000 gallons should be the meter charge unit.

As might be expected, there was a spirited discussion on this paper, during which a variety of opinions were expressed. Mr. F. A. W. Davis, of Indianapolis, thought that for private companies sliding scales were necessary to the production of profits.

FIRE SERVICE METERS.

The evolution of a meter, or of a meter-registering device, adapted to private services and satisfactory to fire insurance interests was described by Mr. E. V. French, Engineer-Inspector of the Factory Mutual Insurance Cos., Boston, Mass. A weighted clapper serves to form a differential check valve which diverts water through an ordinary 3-in. disk meter, placed on a by-pass. With small flows all the water is by-passed through the meter and is registered on an ordinary dial. Large flows and increased pressures raise the clapper valve and in so doing operate a so-called horn which, with proper lever and other combinations, throws a second set of gearing into motion. This gearing operates a second registering dial, by means of which the meter registers as a proportional meter. To get the actual quantity of water which has passed the meter at any time the two dial readings are added together. Special pains have been taken to secure accuracy in this device, and tests indicate that this has been accomplished within reasonable limits. The horn has been adjusted to give a correct registration while the latter is being changed from direct to proportional. The pressure losses on a 6-in. fire main, due to the whole apparatus, are 4 lbs. up to the time the clapper is raised, then 1½ lbs., then a gradual increase until at 6½ or 7 lbs. a flow of 1,800 gallons per minute is reached.

The Inspection Department of the Mutual Factory Cos. intends to make this new apparatus generally available soon. The device was credited by Mr. French to the department as a whole, and particularly to Messrs. Ezra Clark, Geo. F. Hiller and Edward W. Sibley.

In discussing this paper, Mr. Frank C. Kimball, of Boston, said that a meter was now available which is satisfactory to the insurance people, "and that is saying a good deal." He thought it fully met the desires of water-works men, also. Mr. Tilden, of the Hersey Manufacturing Co., on being called for, described the Hersey detector. Both it and the meter just described have a weighted check valve and also a by-pass, but the latter measures all and the former only a part of the water. Mr. Robert J. Thomas, of Lowell, thought each device would have a field of usefulness.

(*The report contained the multiple minimum schedule as adapted by Mr. Coffin to a small new works at Merrimac Mass. For that schedule and a further discussion of its features see Eng. News, Nov. 3, 1904.—Ed.)

COMMITTEE ON UNIFORMITY OF HOSE AND HYDRANT THREADS.

Through Mr. Geo. A. Stacy, of Marlboro, Mass., this committee recommended the National Fire Protection Association standard for hose and hydrants threads; 7½ threads per in. and 3 1-16-in. outside diameter for 2 ½-in. hose. Mr. Griswold having been called on, stated that this standard was adopted by the American Water-Works Association in May, 1905, and by both the International Association of Fire Engineers and the National Firemen's Association in August, 1905. Some 70% of all the 2½-in hose in the United States now complies with or can be adapted to the standard. The desirability of uniform hose threads was illustrated by the fact that at the great Baltimore fire the hose of the New York Fire Department had to be wired to the hydrants and packed at the junction as best it could be. Even the hose of Catonsville, a suburb of Baltimore, did not fit the Baltimore hydrants.

The convention accepted the report and adopted the standard recommended.

During the convention a committee on right or left turns for hydrants and gates and on uniform size and shape for hydrant nuts and stems was appointed, as follows: Messrs. Frank L. Fuller, Frank C. Kimball and Edward V. French, all of Boston.

WATER-WORKS ACCOUNTING.

A paper with the foregoing title was read by Mr. John F. J. Mullhall, of Boston. It outlined an apparently complete system of water-works bookkeeping. The author's strong condemnation of the card system for any financial account gave rise to animated discussion, during which several members of the association stated that the system had given satisfaction with them and one member thought it unsatisfactory. All, including Mr. Mullhall, agreed that for many purposes card systems are of great value.

THE RELATION OF INTENSITY OF TYPHOID FEVER TO CHARACTER OF WATER CARRIAGE.

In a brief paper on this subject, Prof. W. P. Mason, of Troy, N. Y., stated that river-borne typhoid was less fatal than well-borne, due to the greater length of time between the transmission of the germs from one patient to another in the case of river infection and the consequent lessened number and virility of the germs. This statement was borne out by statistics and it was supported by Dr. Geo. A. Soper. In the course of the discussion, Mr. M. N. Baker, of the editorial staff of this journal, and others spoke of the great need for better typhoid statistics, particularly reports of cases, and also of the advisability of studying the records of diarrhoeal diseases. Speaking of the latter, Dr. Soper remarked that doubtless many notable epidemics of typhoid might have been averted by heeding diarrhoeal danger signals.

MUNICIPAL WATER SOFTENING AT [illegible]LIN, O.

A paper on this unique little plant, presented by Mr. W. B. Gerrish, of Oberlin, O., is given in abstract elsewhere in this issue. What would have been an important discussion on the paper was practically throttled by a reversion to the card system of accounting.

COPPER SULPHATE AND WATER SUPPLY.

The whole of the long morning of the third day of the convention was devoted to a symposium on this subject. The remarks of the eight formal and a number of informal speakers, even in largely condensed form, occupy so much space and withal are so important that they are given separately elsewhere in this issue.

CLOSING SESSION.

Friday evening was devoted to addresses accompanied by lantern slide views, the program including "Some Features of Estimating Stream Flow in New England," by Mr. H. K. Barrows, of Boston, and "The Water Supplies of the New York Metropolitan District, with Special Reference to their Purification," by Mr. Geo. C. Whipple, of New York.

A SYMPOSIUM ON THE RELATION OF COPPER SULPHATE TO WATER SUPPLY.

It is now some two years since Dr. Geo. T. Moore directed the attention of a few men to the use of copper sulphate for the treatment of algae-infected water supplies, and less than a year and a half since the subject was brought generally before the public by Drs. Moore and Kellerman.* Since May, 1904, the use of copper sulphate for the prevention of tastes and odors in water has extended rapidly and many records of practical experience with that salt have been published in our columns. Following some of the suggestions in the bulletin named copper sulphate has been tried in water as a germicide, chiefly in laboratory experiments, and it has also been applied to water filtration in connection with mechanical filters.†

At the annual convention of the New England Water-Works Association held in New York Sept. 13 to 15, 1905, a whole session was devoted to a "Symposium on the Relation of Copper Sulphate to Water Supply Matters." There were eight formal contributors to the discussion, six of whom were present and two of whom sent papers which were read. The full discussion, when printed, will form a valuable number of the Journal of the New England Water-Works Association. The following condensed notes of the discussion will give some idea of the trend of thought and experience as expressed at the convention and will doubtless stimulate interest in the complete report.

As may be seen from our notes, a variety of phases of the subject were presented, and on some points there was a radical difference of opinion, particularly as to the reliability of either copper sulphate or copper foil as a germicide, and as to the possible harmful effect of copper upon the human system.

THE GENERAL PROBLEM, WITH SPECIAL REFERENCE TO ALGAE.—As was fitting, the discussion was opened by Dr. Geo. T. Moore, who reviewed briefly his early work with copper sulphate. He pointed out that the use of this agent for the removal of algae has limitations and demands a thorough knowledge of the specific organism to be fought. Copper sulphate to the amount of only 1 part in 50,000,000 of water may be sufficient; or 1 in 1,000,000 may be required; or the treatment may be wholly impracticable. Fortunately, the worst taste and odor producing organisms are the most susceptible to treatment. A novel use of copper sulphate was its successful application to rid a

*See Eng. News, May 26, 1904, for a reprint of a greater part of Bulletin No. 64, United States Bureau of Plant Industry," by Geo. T. Moore, Physiologist and Algologist in Charge of the Laboratory of Plant Physiology, and Karl F. Kellerman, Assistant in Physiology, issued May 7, 1904. A later bulletin from the same source is No. 76, issued April 3, 1905.

†See Eng. News, May 25, 1905, for a description of such use at Anderson, Ind.

fish pond stocked with bass of pickerel, the latter being more susceptible than the former to the toxic effect of the salt,

COPPER SULPHATE AND TYPHOID FEVER FROM UNFILTERED SURFACE SUPPLIES.—Prof. W. P. Mason, of Troy, N. Y., said that while there was no doubt about the algae side of the question, he would not feel like dosing polluted water so heavily with copper sulphate as would be necessary to remove danger from typhoid. Treatment against taste and odor is required at but rare intervals, but against sewage contamination it would be necessary 365 days in the year. A cholera epidemic is so rare an occurrence in America that copper treatment might be warranted on such an occasion. It is doubtful, the speaker said, whether we know all that is to be known about the effect of the continued use of copper on the human system.

DESTRUCTION OF TYPHOID GERMS.—Mr. D. D. Jackson, of Brooklyn, expressed himself as in accord with Dr. Mason's remarks in so far as they related to the continued use of copper against typhoid fever, but he held that on special occasions such use might be warranted. Many laboratory experiments made by Mr. Jackson had shown that the ordinary laboratory typhoid culture is far less strong than a culture directly from the bowels. In two cultures from a dead man, 1 part of copper sulphate in 50,000 parts of water was required to kill typhoid germs. Pathogenic germs in the numbers usually occurring in water are killed by 1 part per 2,000,000 of copper sulphate, while in polluted waters 1 part per 1,000,000 would attenuate vigorous growths and kill many attenuated growths of the typhoid germ. A somewhat extended discussion of copper sulphate and water supplies, presented by Mr. Jackson on another occasion, is given elsewhere in this issue.

GERMICIDAL PROPERTIES OF METALLIC COPPER.—Prof. Henry Kraemer, of Philadelphia, sent a paper describing some experiments which convinced him of the deadly effect of copper foil or copper vessels on typhoid germs after 2 to 4 hours' exposure. He expressed himself most emphatically in favor of the wide use of copper as a germicide and as preferable to any other method of water purification. He believed that the agent has no toxic effect on man. In support of the latter opinion he cited the use in his own family for a year of water treated with metallic copper and of the use of copper in solution for washing vegetables.

TOXICOLOGICAL ASPECTS OF COPPER.—Prof. Herbert E. Smith, of New Haven, Conn., said the effect of large doses of copper on man was that of an irritant rather than a systemic poison. Repeated small doses do not lead to systemic poisoning nor do they give rise to deleterious effects. Assuming the application of 1 part of copper sulphate to 1,000,000 parts of water, and that a person drinks two quarts of water a day, only 1-130 grain of copper would be taken into the system. Copper occurs naturally in grain and in vegetables and is used in the latter as a preservative, all without known harmful effect on man. Professor Smith concluded that the salt as used to prevent algae growths was not dangerous to man. As to its use as a bactericide, he did not know how much copper would be required.

COPPER SULPHATE IN THE PURIFICATION OF HARD AND TURBID WATERS.—As is well known, many of the waters of the West are hard and turbid, and thus present special problems when treated for any purpose. Mr. J. W. Ellms, of Cincinnati, sent a paper dealing with this subject. When copper sulphate is applied to some of these waters, it will probably be precipitated within 24 hours. Where necessary, lime may be added to aid in precipitating the applied copper. Copper sulphate "in sufficient quantities" will destroy typhoid germs. Where copper sulphate is applied to water which is to be filtered, the copper is deposited on the surface of the filter, increasing with the volume filtered. This concentration of the copper combined with the contact afforded between the copper and the germs in the water gives a relatively large germicidal effect with a small amount of copper per 1,000,000 parts of water. The effect of the copper on disease germs in water is worthy of investigation.

COPPER SULPHATE IN CONNECTION WITH WATER FILTRATION AT THE LAWRENCE EXPERIMENT STATION.—This review was presented by Mr. H. W. Clark, Chemist of the Massachusetts State Board of Health, Boston, Mass. The subject named has been studied for a year or more on a large filter tank at the station which had been in use for a dozen years as a slow sand filter. Copper at the rate of 1 part per 1,000,000, and sometimes higher, was applied. The copper penetrated the whole depth of the filter, being found to the extent of 39 parts per 1,000,000 at the top of the sand, 8 parts 12 ins. below the top and 7 parts at the bottom. The filtered water contained from 1.2 to 5.8 parts of copper per 1,000,000. The rate of filtration was from 2,800,000 to 4,700,000 gallons per acre per day.

Experiments on the precipitation of applied copper in tanks showed practically no precipitation of the copper in 24 to 48 hours, and in one case none in 20 days. In general, a long period elapsed before any large percentage of the copper was precipitated. (It should be understood that this was with Merrimac River water, and had nothing to do with algae.—Ed.). This means, Mr. Clark said, that with Massachusetts waters large sedimentation basins would be required if copper sulphate was to be precipitated before the water was applied to the filters.

As to the bacterial efficiency of the filter studied, there was a slight but negligible loss in the percentage of total bacteria removed during the period when the copper sulphate was used.

COPPER SULPHATE APPLIED TO THE EFFLUENTS OF COARSE GRAINED SEWAGE FILTERS.—As a preface to his remarks bearing directly on the topic assigned to him, Mr. G. A. Johnson, of Columbus, O., said that it seems to be generally agreed that 95 to 99% of the typhoid germs added to running water by sewage die out in a few days. The speaker also said, in the course of his remarks, that there are many data to show that typhoid germs in effluents from rapid sewage filters soon die from natural causes. Apparently all typhoid germs can be eliminated from polluted water or from sewage effluents by the use of copper sulphate. By the same means the speaker thought that the pathogenicity of the effluents from rapid sewage filters could be reduced to the standard of effluents from sand filters.

GENERAL DISCUSSION.—Mr. X. H. Goodnough, Engineer of the Massachusetts State Board of Health, Boston, on being called for, read extracts from a long paper detailing trials of copper sulphate on algae infected reservoirs and ponds in Massachusetts. None of these trials were made on water being used for drinking purposes. (The Massachusetts Board has not yet sanctioned such use of copper sulphate.—Ed.). The trials began in 1903 (some months before the issuance of the copper sulphate bulletin by the U. S. Department of Agriculture.—Ed.) and have continued to the present date. Varying results were shown by the trials, the general impression on one listening to the paper being that in the majority of cases the algae were suppressed. After treatment, copper was found in some of the waters in notable quantities; some times long after treatment. The experiments have not yet been completed, so no final conclusions have been drawn.

Dr. Karl Kellerman, of Washington, D. C., urged that the character of each water to be treated be carefully studied in advance. The differences in the character of Western and Eastern waters probably accounts for the different copper precipitation reported by Mr. Ellms and by Mr. Clark. New England waters seem to be in a distinct class. Western waters seem to precipitate copper sulphate readily.

Mr. Phelps, of the Massachusetts Institute of Technology, Boston, reported some tests of the effect of copper canteens on contained water, made by him for the U. S. Geological Survey. The canteens were first cleaned with oxalic acid, but after that they were not specially cleaned. Using unsterilized, unfiltered Boston tap water dosed with typhoid germs, it was found that the water in the clean cans dissolved 2 parts of copper per 1,000,000 parts of water, but this diminished until at the ninth test (time not stated.—Ed.) less than ½ part per 1,000,000 was taken up. At the start, the typhoid-killing efficiency was large, but not complete, 24 hours of water storage in the canteens leaving 6 to 10 typhoid germs per cu. cm. Later, 30 to 40 typhoid germs were left. Only once were all these germs eliminated. Other waters have been tested. Turbid waters and hard Western waters nullify the effect of copper canteens on the typhoid organism. During his tests, Mr. Phelps used three strains of typhoid cultures, two years, one year and one month old, but the results with the different strains were not appreciably different.

Mr. Robert Spurr Weston, of Boston, thought that a large part of the fish killing due to copper sulphate was caused by a streaky application of the salt, resulting in concentration at points. The salt appears to affect the cell contents of the gills of fish, causing strangulation. Mr. Weston suggested a copper solution, applied as a spray, to get more perfect diffusion.

Dr. Geo. A. Soper, of New York, strongly questioned the advisability of relying upon copper sulphate to check typhoid epidemics in actual progress. He thought the studies of copper sulphate and copper, thus far, had been made in laboratories under the best possible conditions of control. In applying disinfectants during epidemics the exact proportions to be used must be known, so that not "some good," but complete disinfection will result. From experiments conducted by the speaker and others, it appears that it is not certain that 1 part of copper per 75,000 parts of water will destroy all typhoid germs, but it is known that so much copper will make the water objectionably opalescent. Typhoid germs probably aggregate in masses of feces which must be penetrated by the copper sulphate to be effective.

Mr. Allen Hazen, of New York City, remarked that the use of copper sulphate against typhoid and cholera was suggested in Germany 10 or 12 years ago, but after consideration the German engineers were unwilling to take responsibility for giving the people enough copper sulphate to destroy the germs.

After the general discussion, the program speakers closed briefly in reverse order. Dr. Moore remarked that he thought all the workers in this field would go home and try to clear up discrepancies. It had not been contemplated that the use of copper sulphate would be used for the continued purification of water, but only in emergencies. It is practically impossible, he said, to introduce the use of copper sulphate where local or state boards of health oppose it. The members of such boards are not open to argument.

PURIFICATION OF WATER BY COPPER SULPHATE.*

By Daniel D. Jackson.†

The first experiments of the writer on the treatment of water with copper sulphate were made upon Baisley's Pond, Jamaica, L. I., on Sept. 6, 1904. As all of the water used from it is subsequently filtered, it was considered that there could be no possibility of the presence of copper sulphate after filtration as this chemical does not remain in solution in the water, but is immediately precipitated by the carbonates present. At the time of treatment the pond contained a considerable growth of Anabaena. On account of its gelatinous nature this organism was giving great trouble in the mechanical filters and had at times caused a reduction of as high as 25% in the rate of filtration. Table I. gives the results obtained.

TABLE I.—Reduction of Algae in Baisley's Pond Due to Copper Sulphate Treatment.

Date, 1904.	Location.		Total organisms.	Anabaena.
Sept. 6,	Top	Before treatment	1,640	800
" 6,	Bottom	" "	435	265
" 7,	Top	After treatment	155	55
" 7,	Bottom	" "	235	0
" 8,	Top	" "	105	0
" 8,	Bottom	" "	150	0
" 9,	Top	" "	125	0
" 9,	Bottom	" "	125	0
" 10,	Top	" "	175	0
" 10,	Bottom	" "	105	0
" 30,	Top	" "	140	0
" 30,	Bottom	" "	100	0

The amount of copper sulphate used was approximately

*Abstract of a Paper Read at the Annual Convention of the American Society of Municipal Improvements, Montreal, Sept. 5 to 9, 1905.

†Chief Chemist, Department Gas, Electricity and Water Supply, Brooklyn, N. Y.

1 part in 8,000,000 parts of water, and the expense of treatment for 100,000,000 gallons was $7.50.

On the third day after treatment the wash water of the filter was reduced to 3%, causing a saving in the yield of the plant for that time of 1,000,000 gallons per day.

Copper sulphate experiments were next made on an extremely heavy growth of Clathrocytis, an organism closely related to Anabaena, and one which is often found in large quantities in surface waters. This microscopic growth occurred in the Prospect Park Duck Pond near Flatbush Ave., Brooklyn, in such enormous amounts as to entirely cover the surface of the pond with a thick green slime. Table II. gives the results obtained by the treatment of this organism.

TABLE II.—Reduction of Algae in Prospect Park Duck Pond Due to Copper Sulphate Treatment.

Date.	Location		Units of Clathrocytis.
Sept. 9,	Top	Before treatment	700,000
" 9,	Bottom	" "	10,000
" 10,	Top	After "	620,000
" 10,	Bottom	" "	83,000
" 11,	Top	" "	94,000
" 11,	Bottom	" "	35,000
" 12,	Top	" "	7,625
" 12,	Bottom	" "	2,550
" 13,	Top	" "	560
" 13,	Bottom	" "	640

The amount of chemical used was approximately 1 part in 4,000,000, and the cost of treating the pond was $2. During the present summer this treatment has been extensively used in the Brooklyn Department of Parks and has been found effectually to remove the disagreeable odor and unsightly appearance occurring so often in the park ponds, and in the dilutions used there has not been the slightest injury to shrubbery or fish.

During the month of September, 1904, a considerable growth of an algae known as Aphanizomenon occurred in one of the sources of water supply for the Borough of Manhattan and its presence was the cause of a considerable taste and odor in the water.

On Sept. 30 the surface of this reservoir was treated with copper sulphate in the proportion of 1 part to 8,000,000 parts of water. This amount of copper sulphate, providing it all remained in the water, would necessitate an individual to drink 100 gallons of water a day to get the slightest physiological effect from the copper, and there is, therefore, no question about the safety of such a treatment as this, especially as only one or two treatments a year are necessary. Table III. gives the results obtained.

TABLE III.—Reduction of Algae Due to Copper Sulphate Treatment, Borough of Manhattan Water Supply.

Date.	Location.		Total organisms.	Aphanizomenon.
Sept. 30,	Top	Before treatment	4,680	4,100
" 30,	Bottom	" "	4,115	3,725
Oct. 1,	Top	After "	1,020	755
" 1,	Bottom	" "	565	285
" 2,	Top	" "	490	240
" 3,	Top	" "	140	0
" 3,	Bottom	" "	275	0

The figures of the above table show that this form of blue-green algae was completely removed on the third day after treatment. From that time on the water has been clear and free from unpleasant odors.

Later in the year the microscopic organism Uroglena occurred in large numbers in one of the Brooklyn supply ponds. This organism produced a strong fishy taste and odor in the water, and considerable numbers were being transported to the Ridgewood and Mt. Prospect distributing reservoirs. In order to prevent any further influx into the reservoirs of this odor-producing organism, the pond was shut off and a treatment with copper sulphate was made on Nov. 23, 1904. As this is an extremely delicate organism a dilution was used of only 1 part of copper sulphate to 20,000,000 parts of water. Table IV. gives the remarkable results obtained.

TABLE IV.—Reduction of Uroglena Due to Copper Sulphate Treatment, Brooklyn Water Supply Pond.

Date.	Uroglena (Units per cc.).
Nov. 23, Before treatment	1,100
Nov. 25, Two days after treatment	450
Nov. 27, Four days after treatment	0

During the present year no trouble has been experienced from microscopic growths in this pond.

In the spring of the present year one of the Brooklyn sources of supply was treated with copper in order to remove a growth of Asterionella. It was found that 1 part of copper sulphate in 3,000,000 parts of water was necessary. Table V. shows the results obtained.

TABLE V.—Reduction of Asterionella Due to Copper Sulphate Treatment, Brooklyn Water Supply.

Date.			Asterionella.
May 2,	Before	treatment	2,850
" 3,	"	"	3,400
" 4,	"	"	3,650
" 5,	After	"	2,450
" 6,	"	"	2,350
" 7,	"	"	2,200
" 8,	"	"	1,275
" 9,	"	"	875
" 10,	"	"	640
" 11,	"	"	550
" 12,	"	"	380
" 13,	"	"	310
" 14,	"	"	260
" 15,	"	"	200
" 22,	"	"	25

It will be seen from the above figures that not only does Asterionella require more copper for its removal, but the reduction in the organisms appears to take place much more slowly.

AMOUNT OF COPPER NECESSARY FOR TREATMENT.—The amount of copper required to remove a growth of micro-organisms from water depends to a large extent upon the structure of the particular organisms present. A definite amount of copper is required each time the treatment of any particular genus is made, excepting when the growth is extremely heavy, when it may be even necessary to double the quantity. In general the amounts of copper so far found to be required are as follows:

DIATOMACEAE.

Asterionella	3,000,000	Synedra	3,000,000
Melosira	3,000,000	Fragilaria	4,000,000

CYANOPHYCEAE.

Coelosphaerium	4,000,000	Anabaena	8,000,000
Oscillaria	5,000,000	Aphanizomenon	8,000,000
Microcystis	6,000,000	Clathrocystis	8,000,000

CHLOROPHYCEAE.

Draparnaldia	3,000,000	Closterium	3,000,000
Scenedesmus	3,000,000	Volvox	4,000,000
Conferva	3,000,000	Spirogyra	5,000,000
Raphidium	3,000,000	Hydrodictyon	10,000,000

PROTOZOA.

Chlamydomonas	2,000,000	Mallomonas	2,000,000
Cryptomonas	2,000,000	Dinobryon	3,000,000
Euglina	2,000,000	Synura	10,000,000
Glenodinium	2,000,000	Uroglena	20,000,000
Peridinium	2,000,000		

It will be seen from the results that if the nature of the growth is not known that a treatment of 1 part in 2,000,000 parts of water will be sufficient to accomplish the work. If, however, the organism is known a much smaller amount may in most cases be used.

RECURRENCE OF GROWTH.—It sometimes happens that a short time after a pond has been treated, and the growth removed, a second growth will develop. This second growth may be the same organism as the first, or it may be an entirely different organism. The fact that a second or third growth sometimes develops is in no way remarkable when we consider that the copper added usually precipitates to the bottom in a few days and becomes inactive in the water above. If the conditions are favorable for a second development there is nothing but the reduction of spores to prevent its occurrence, but it has been noted that it is only in ponds or reservoirs highly contaminated with organic matter, and having large deposits of muck at the bottom, that such repeated growths do occur. In such cases if the ponds are not cleaned it may be necessary to treat them four or five times during the year. It has been claimed that a pond once treated with copper sulphate will require a stronger treatment for the second growth. This has not been the experience of the author.

INFLUENCE OF COPPER ON BACTERIA IN WATER.—When a heavy growth of algae is destroyed by treatment with copper, the dead organisms furnish food for the development of bacteria, and unless the algae are rapidly precipitated to the bottom of the pond, then with the fall in algae comes a marked rise in bacteria. Water bacteria require very strong solutions of copper to produce the slightest effect upon them. Table VI. shows the effect upon the common water bacteria produced by the treatment of copper (1 part in 3,000,000 parts of water) in a reservoir containing Asterionella.

TABLE VI.—Effect of Copper Sulphate on Common Water Bacteria After Reduction in Asterionella.

1905		Microscopic organisms.	Bacteria.
March 13,	Before treatment	4,625	405
" 14,	After "	3,645	600
" 15,	" "	3,325	6,000
" 16,	" "	1,925	11,000
" 17,	" "	1,850	12,000
" 18,	" "	1,575	45,000
" 20,	" "	1,350	100,000
" 21,	" "	900	440,000
" 22,	" "	350	630,000
" 23,	" "	350	310,000
" 24,	" "	400	107,000
" 25,	" "	360	80,000
" 26,	" "	300	64,000
" 27,	" "	270	50,000
" 28,	" "	150	37,000
" 29,	" "	100	20,000
" 30,	" "	100	8,000
" 31,	" "	60	3,500
April 1.	" "	25	860

EFFECT OF COPPER ON TYPHOID BACTERIA.—Experiments by the author show that B. Coli communis and the B. Typhi abdominalis of the attenuation usually found in water are both destroyed by copper sulphate in the proportion of 1 part to 2,000,000 parts of water. But these results are not obtained when fresh virulent typhoid germs are added to water. A strength of 1 part to 50,000 parts of water is then required.

In case of an epidemic the latter strength is the only one which would be sure of accomplishing absolute disinfection, while the smaller amount would attenuate virulent typhoid or kill attenuated typhoid. The strength of 1 to 50,000 would give a noticeable taste and be likely to produce a physiological effect upon the consumer and is not to be recommended. It is probable that a treatment of such contaminated waters in a strength of 1 part in 1,000,000 will sufficiently attenuate the typhoid germs so as to render them much less dangerous, and at the same time, be dilute enough to prevent any physiological effect upon the consumer. In solutions of this strength a slight taste is noted, as has been pointed out by Weston.‡

GUTTERS AND CROSSWALKS FOR MACADAM PAVEMENTS.*

By W. G. Stewart.†

Macadam pavements, as usually constructed in cities and towns, are built between curbs, and this form of construction calls for a gutter and crossings. Of course in the country these adjuncts are not used.

On the "Model" street at the World's Fair in St. Louis some fine samples of pavement were shown without curb or gutter, the pavements being built to the turf on either side in a straight, clean-cut line, a well-kept lawn extending from this line to the walks. Here was shown asphalt, bitulithic, brick and macadam, all so crowned and graded as to make a beautiful finish; but in cities and towns a proper curb and gutter are necessary, and generally crossings; though in some cities the latter are omitted as they tend to the disintegration of the pavement at these points where the more unyielding crossing causes the macadam to be cut away on either side.

Brooklyn has some miles of pavement constructed in this way; but generally it is considered desirable to have a suitable crossing at the intersecting streets, at least, and in Rochester they are so constructed, and also, where the distance is great between the intersecting streets, they are placed midway between such streets. Our practice has been in the past to construct the gutters and crosswalks with stone on a sand foundation, and later with block stone on a concrete foundation, the stone running parallel with the curb. The crossings, with cut stone flags 18 ins. wide, the joints cut on the diagonal, three courses of flagstone placed 6 ins. apart; a course of flagstone filling this space and 3 ft. of paving on either side of the flagging, making the crossing 11½ ft. wide. This stone construction, while very satisfactory, is also very expensive, but when well grouted the gutters are smooth and stable.

A more recent construction that seems to combine all the good qualities of the stone, while being much cheaper, is of brick, preferably the block form, on from 4 to 6 ins. of concrete and thoroughly grouted with Portland cement grout mixed in the proportions of 1 to 1. These gutters are 3 ft. in width generally, though the width will vary 2 or 3 ins., depending on the kind of brick used; the crossings being 11 ft. in width.

At first the brick were placed in parallel courses with the curb, but this made a straight joint with the macadam allowing the traffic to cut a rut along the joint and the wheels to travel along the length of this rut tending to wear the edges and also to displace the brick.

Another plan was tried by placing the brick at an angle with the curb, and in order to break joints properly, the cutting of a brick in every other course. This mode of construction made a kind of tooth edge where joining the macadam, with considerably less tendency to cut away at the joining of the two. In this way the brick wear better than when placed parallel or at right angles to the curb. This will be found to be the case in a more marked degree where the street is entirely paved with brick. The traffic will be smoother and the brick wear longer. Placing the brick gutter at right angles to the curb also requires the cutting of every other course, in order to break joints.

In any mode of construction it is always desirable to have the concrete foundation project a few inches beyond the brickwork for better support to the brick, which are liable to be pressed below grade at the outer edge by the steam roller.

A more recent construction, and one that has proved the most satisfactory of any, has been the herring bone fashion that combines all the advantages, with none of the defects, of the other plans. One of the greatest advantages is that no cutting of the brick is necessary and the outer edge is left toothed, allowing the macadam to be pressed into the toothing by the roller, thus making a better joint between the brick and macadam; and the slightly extra work of laying in this fashion is more than offset by the fact that no cutting of the brick is required, while the joints are properly broken without effort on the part of the bricklayers, and in a uniform manner.

Crossings can also be laid in this manner with decided advantage as they are more securely bound together, and when properly grouted and traffic kept off for two weeks afterward, for a proper setting of the grout, will present a surface as true as asphalt, and depressions will never be found for the retention of water.

It is true that a well-made and well-kept macadam pavement generally presents a good crossing at any point, but as they are not generally well kept, and depressions retaining water are apt to be frequent in a well-traveled street, the crossings are a decided advantage to pedestrians, if not to the roadway and vehicles.

‡Journal of the Mass. Assoc. of Boards of Health, Vol. XIV., No. 3, August, 1904.

*A paper read at the Montreal Meeting of the American Society of Municipal Improvements.

†First Asst. City Engineer, Rochester, N. Y.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
SAN FRANCISCO: Rialto Building
BOSTON: 170 Summer Street
ATLANTA: Austell Building
RUDOLF MOSSE, BERLIN AND HAMBURG, GERMANY

SUBSCRIPTIONS

United States and Possessions, Canada, Mexico and Cuba, One Year, $5.00.
Foreign Countries, Regular (Thick Paper) Edition, One Year, $9.00. (£1-18-0).
Foreign Countries, Thin Paper Edition (Construction News Supplement Omitted), $5.00. 21 Shillings, 25 Francs or 21 Marks.
Remit by Post-Office or Express Money Order, Draft on New York or London, or by Registered Letter. Notice of change of address should reach us one week in advance of removal. The old as well as the new address should be sent.
Receipts for Subscriptions will not be sent unless requested, the changing of the expiration number being considered sufficient. The number on the address label indicates when subscription expires, the last figure indicating the year, and the one or two preceding figures the week of that year. 52-5 means the 52d week or December 28, 1905.

ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See pages 26 and 27.

Copy for regular, or "Contract," Advertisements should be received one week before publication; "For Sale" and "Situations Wanted" Advertisements by Tuesday, and "Proposal" and "Situations Open" Advertisements by 11 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

The New England Water-Works Association, notwithstanding its local origin and name, ranks in distribution of membership, character of work and broad fraternalism with the best of our national technical societies. The convention just held by the association in New York was remarkably good throughout, but was particularly notable in respect of two features, the symposium on copper sulphate and water supply and the paper describing a combined direct and proportional meter for large private fire services. Mention may also be made of the adoption of the standard thread for fire hose and hydrants recommended and adopted by the National Fire Protection Association and also adopted by the American Water-Works Association and two national organizations of firemen. So much space is given elsewhere in this issue to the copper sulphate symposium that nothing more need be said of it here. Attention may well be called, however, to the triumph of the New England Water-Works Association in the matter of metering private fire services and in the praiseworthy action of the engineers of the Factory Mutual Insurance Cos. in so far receding from their initial uncompromising opposition to meters on such services as to actually perfect a meter and accessories which appears to meet the approval of water-works and fire protection interests alike. At one time it looked as though all efforts to secure cooperation between the two interests would not only fail but would also be followed by bitter conflict; now all seems harmonious and further cooperative work is promised. True, there is still a difference of opinion as to whether or not factory owners should be charged for water used for fire protection, but the development of a meter that will show just how much water is used for this purpose and how much is consumed for mill purposes and wasted in leaks will go far towards settling all questions of compensation. It is the surreptitious use and the careless waste of water from private fire services that arouses the indignation of the water-works superintendent. To have brought about an apparent solution of so important a question with good feeling on all sides, is another long mark to the credit of the New England Water-Works Association.

The remarkable labor situation in the South set forth by Mr. Hazlehurst in this issue is a matter of more than passing interest to engineers and contractors since in every class of engineering works labor is an important element and not infrequently a controlling factor. Engineers and others in the North have always been accustomed to assume that cheap labor prevailed in considering any proposition for Southern engineering work. From the prices quoted by Mr. Hazlehurst, however, unskilled labor is quite as costly, all things considered, in the Southern cities as in the cities of the North Atlantic states.

As for the non-dependability of colored labor in the South, much has been published before; but Mr. Hazlehurst gives actual figures which cannot fail to interest engineers and contractors. From these figures, the average colored laborer works only half the time, and lies idle the other half. He lives a simple life and the wages of three days' work suffice for the necessities of a whole week. The strenuous life has for him no charm, and it would be hard to convert him to Mr. Russell Sage's anti-vacation theory. Possibly he extracts more pleasure out of life than some of those who, year in and year out, chase after dollars which they cannot use; but such philosophic speculations do not answer the question how the workers are to be secured for the work that must be done. Mr. Hazlehurst looks to immigration to solve the difficulty, and suggests governmental action toward the distribution of immigration. To us, however, it seems as a practical matter well-nigh hopeless to expect any action by Congress; and the more probable course would appear to be a gradual turning of immigrants from Southern Europe toward the Southern states through the natural law of supply and demand. Few immigrants have gone South hitherto largely because the low prices for negro labor in the past have made the opportunities for immigrants better elsewhere. Present high prices for labor, however, should certainly draw Italians and others toward the South and should help in some degree to solve the perplexing situation described by Mr. Hazelhurst.

The deepening of the shaft of the Acadia Coal Co. at Stellerton, Nova Scotia, from the 952-ft. level to the 1,110-ft. level, or 128 ft., in the 27 working days of last month establishes a rather unusual record of progress in shaft sinking. This work is briefly described in another column of this issue, and in comparing it with other instances of rapid shaft sinking it is important to note the considerable dimensions of the shaft, 12 ft. 4 ins. × 24 ft.; the depth of the hoist, an average of 1,046 ft.; and the fact that 100 ft. of the depth sunk had to be fully timbered. These circumstances all contributed to reduce the speed of excavation as compared with smaller, untimbered shallow shafts. On the other hand, the contractor of the Stellerton work had the advantage of an unusually speedy and efficient hoisting plant. With all said, however, the record of progress quoted is a notable one. In connection it will be of interest to note another example of rapid shaft sinking, also a Canadian job, which has recently come to our attention. To excavate the tailrace tunnel of the Niagara Falls power plant of the Electrical Development Co. of Ontario a 7 × 20-ft. shaft was sunk 101.5 ft. through shale and limestone, and, in addition, 15 ft. of 7 × 14 ft. drift was run from the shaft bottom during the month of August, 1903. The hoist in this case was small, the shaft being only 152 ft. deep, and there was very little timbering. The fastest progress in shaft sinking of which we have been able to find record was made in South Africa, and is described in the Transactions of the American Institute of Mining Engineers for February, 1904. A shaft 6 × 21 ft. in section was sunk 858 ft. in five months, and during the last month, May, 1903, the progress was 213 ft. 6 ins.

The very interesting article on the concrete lining of the Jerome Park Reservoir, which we publish in another column of this issue, raises a question of practice in lining reservoirs with concrete which is worth a word of comment. It has come to be quite generally regarded as necessary to provide against cracks due to expansion and contraction and possible settlement of the bottom and slopes by placing the lining in squares or sections separated by a joint of asphalt. Most reservoir linings of concrete built in recent years have been constructed in this manner. It will be noted that the engineers of the Jerome Park Rezervoir work have departed from this practice; they are placing their concrete in 16 ft. strips extending continuously across the reservoir. Crosswise of these strips there are no joints and in the other direction there are only the planes of weakness produced by abutting the new concrete against the old concrete of the preceding strip. After the reservoir is filled with water there will be, of course, little chance of changes of temperature sufficient to cause expansion cracks, and the engineers probably reasoned that the time during which the lining would be exposed to atmospheric changes in construction would be too short to result in damage to the concrete. This is a matter which must be determined, of course, for each individual case; where there is much likelihood of the work being uncovered by water for any time, it would seem to be more safe to adopt such precautions as practice and experience have determined to be efficacious.

Considerable space in this issue is devoted to a statement by Mr. Richard L. Humphrey, M. Am. Soc. C. E., of the results of the testing work carried on during the Louisiana Purchase Exposition at St. Louis, Mo., by the Association of American Portland Cement Manufacturers. This work is of interest to engineers in several particulars. It was, in the first place, partly the means of inducing Congress to appropriate the money necessary to conduct during the present year a series of tests on cementing materials, timbers and fuels under the organization described in our issue of Aug. 31. If, as is earnestly hoped by the engineers who are giving so liberally of their time and energy to the task, this auspicious start should finally develop into a liberally endowed governmental testing bureau, the good wrought by the labors which we record would be invaluable. Of this matter we shall have more to say in a future issue. In respect to the test results, per se, it may be said at once that there is little of novelty or of striking interest to be recorded of the beam tests. The tests of cements, to determine the effect of training on the influence of the personal equation on tensile strength results, and the physical investigations of mortar sands from different sections of the country, are, however, of special interest. So far as we know, no such attempt has heretofore been made in this country to determine the granulometric composition of representative sands for mortar making. In the cement and sand tests the reader of Mr. Humphrey's paper will find much material for future attention and use; the tests of beams and floors and of the large cantilever are noteworthy chiefly for the evidence which they present of the sturdiness of reinforced concrete construction in almost any form of structure.

That a large attendance and numerous and long papers are not essential to a successful meeting may be seen from the report, elsewhere in this issue, of the convention of the Central States Water-Works Association at Columbus, O., last week. The half dozen papers were brief and simple, but they were fruitful of discussion, and that is or should be the best feature of conventions of technical men.

The faith of Mobile, Ala., in the theory that mosquitos and not filth are responsible for the spread of yellow fever appears to have been amply justified by the freedom of that city from the disease during the recent epidemic. This is the more notable because Mobile is in constant steamer communication with Southern ports, some of which, we understand, have been infected with yellow fever.

Acting upon the Pauline doctrine that faith without works is dead, Mobile has conducted a mosquito-extermination campaign which may be found interestingly described elsewhere in this issue by Mr. J. N. Hazlehurst, M. Am. Soc. C. E., Chief Engineer of the Mobile Board of Public Works. A somewhat similar campaign, in the much smaller town of Helena, Ark., was described by Mr. F. H. Wright, City Engineer, in our issue of Aug. 31, 1905. Doubtless many other Southern towns have done equally creditable work and deserve like praise for accepting and acting upon the mosquito theory at a time when the latter is still subjected to ridicule and opposition. But after all, present indications are that New Orleans will present the most remarkable justification on American soil of the soundness of

the mosquito theory. Yellow fever got a strong footing there before it was recognized, and there was a large and ignorant population, besides innumerable mosquito breeding places, to deal with; and yet the epidemic seems to be coming to a close long before the advent of frost.

If the South heeds the lessons of this summer the yellow fever epidemic of 1905 will be the last serious outbreak of the disease on American soil.

THE FIELD FOR ENGINEERS AND ENGINEERING CONTRACTORS IN ARCHITECTURAL BUILDING WORK.

More engineering skill and business ability are required to erect a modern office building than to pave a street. yet the first named class of work is rarely considered as being an engineering enterprise, because architects design and superintend it, or at least are credited as being the designers, although, in fact, the architect's part often consists in ornamenting the design made by an engineer. The building of power plants and factories is likewise regarded as being the particular province of the building contractor, and it is only within recent years that engineering contractors have made a vigorous effort to secure their share of this kind of work. To men who have scanned the course of events it has been apparent that engineers and engineering contractors will not leave the great field of building construction in the hands of architects and architectural contractors. There are reasons why the present is an opportune time for a vigorous attempt on the part of engineering contractors to secure building contracts. We purpose outlining some of the reasons.

To begin with, architectural contractors have been slowly but relentlessly forced to yield to the demands of labor unions, until, in certain cities, a hod carrier receives larger pay than a skilled surveyor who has spent four years in an engineering college. The working hours have been reduced to eight, and wages have risen steadily in all the building trades. As a result of these well-known facts, capitalists have become exceedingly cautious about entering into a contract for the erection of new buildings. They have been deterred not only by the increased cost of building, but by the fear that when the building is half done a strike will occur, tying up their capital indefinitely. But, will not the very same reasons deter capitalists from contracting with an engineering firm for erecting a building? In many cases, yes; but where reinforced concrete can be used for the greater part of a building, no. Concrete workers have as yet formed no unions, and it is doubtful whether any union of unskilled laborers can ever become a serious menace to builders. At any rate, the conditions now are such that a firm of engineering contractors can undertake the erection of concrete buildings with little risk from strikes.

Concrete, moreover, is a building material that should never be used except under skilled supervision and by contractors whose integrity is above suspicion. A firm of contractors which has established a reputation for doing good and honest work, can unquestionably secure a great amount of concrete building work, provided it is able to let capitalists know what it has accomplished, and provided the architects employed by capitalists will design concrete buildings. Architects have been exceedingly slow in adopting concrete as a building material. Ignorance and reverence for precedent probably account for this fact. To meet this condition, certain firms of engineering contractors have organized departments for designing concrete buildings for clients. This plan has its advantages in the present state of affairs, but ultimately engineers and architects connected with no contracting company will prepare the plans for concrete buildings. Indeed, a great field is now open for just such firms of engineers and architects. We use the two names together, for men of the two professions should work together on the problems involved in designing large buildings, and particularly on buildings in which reinforced concrete is largely used.

Another reason why the field of architectural building should be an attractive one to engineers is the present miserable state of the art of drawing specifications for building construction. We have had occasion to criticise unfavorably many specifications for engineering work, but even the poorest of these has been a model of excellence compared with the ordinary specification written by an architect.

Bills for extras are common enough on engineering work, but on architectural work they often make the original contract look like the "extras" and the "extras" look like the original contract. This is due not alone to the changes in the plans asked for by the owner, but to the vagueness of the specifications on important details. While owners of cottages, and residences generally, are noted for their disposition to change their plans, no such charge can be made against the average business man who is putting up a building for business purposes. He may be inveigled into a change of plans, but he is the last man likely to suggest a change of his own volition—he has heard too much about contractors for architectural work. We reason, therefore, that firms of engineers and architects, who are known to be specific to the last detail in their plans and specifications, can command high salaries or commissions as the designers of buildings for business purposes.

There is more than mere speculation in this statement. In New York City a large and very successful firm of contractors advertises in the daily papers that they insure their patrons against increase in the cost of a building over the estimated cost. They offer the services of their engineering department to a patron, and with their contract is a "cost insurance." They have no bills for extras.

Another well-known contracting firm does building work on cost plus a fixed sum basis. The forms of contract vary in the two cases, but the strong "talking arguments" presented to business men are much the same, namely, that the firm can be relied upon to do work well and quickly because of its past record, and that no bills for extras are possible.

We have indicated that concrete buildings form perhaps the most promising type of building construction work for engineering contractors to begin upon, but we see no good reason why engineering building work should be limited to concrete even under present conditions.

Perhaps the great majority of architectural building contractors have worked up from the ranks of masons and carpenters. Their early training has not been such as to make them skilled in the art of cost recording and business management in general. They have succeeded in spite of their deficiencies, and because they have had to meet only one kind of competitors, namely, their own kind. There is not the slightest doubt that contractors whose training has been obtained on engineering work, where "rush jobs" are more common and where the work has developed a higher quality of business management, can compete successfully with building contractors in their own line of work. A beginning is rendered easy by virtue of the fact that the labor item does not form so great a percentage of the total cost as in most classes of engineering contract work. By taking contracts for comparatively plain buildings at first, and by keeping careful cost records, it will take an engineering contractor but a short time to learn what different kinds of building work are worth, and how each kind can be most expeditiously handled. Then by a system of daily progress reports, it is possible for one firm to handle a number of buildings simultaneously; and to push each job to completion faster than is common under the direction of the ordinary small building contractor.

By systematizing their business, managers of factories have found it possible to handle several factories from one office. The astonishing success of such organizers as Andrew Carnegie in the manufacture of steel, and of a dozen other men whose names come to the tongue at the mere mention of business success, should indicate the inevitable trend toward centralization. This does not mean that there will be fewer managers of business affairs in the future, but that there will be fewer competing companies, and that the old time go-it-alone manager will become part of a greater and more perfect productive organization. In building construction the movement has just begun toward the development of large building companies, and it is highly probable that men who have received their training on engineering work will be among the first to win success in this, to them, new field of action. Already they are accustomed to do big things, to think in tons where the builder thinks in pounds, and we confidently expect to see engineers and engineering contractors at the head of the big building companies of the future.

LETTERS TO THE EDITOR.

The Cubical Contents of a Wheelbarrow.

Sir: In reference to the capacity of wheelbarrows I find, on looking over some old notes of 1879 made while in charge of the Davis Island Dam, Ohio River, as Assistant Engineer, the following figures. The work consisted in removing the earth filling from one cofferdam and placing it in another cofferdam.

Date July, 1879.	Horizontal distance, ft.	Barrow loads by count.	Cu. yds. by measurement.	Cu. yds. per barrow load.
1	84.2	1,135	79.8	0.0703
2	130.5	1,192	82.4	.0691
3	192.5	1,045	62.3	.0596
5	234	616	42.0	.0682
7	272.5	1,051	51.2	.0487
8	300.3	956	30.4	.0527
9	316.8	957	40.9	.0425
10	341.8	1,007	45.2	.0449
Totals	.....	7,959	454.3	0.0570

Notes.—Weight per cu. ft., 80.3 lbs.; old cofferdam rods in the way; vertical distance not noted; sandy loam; 0.0570 cu. yds. equals 1.54 cu. ft.

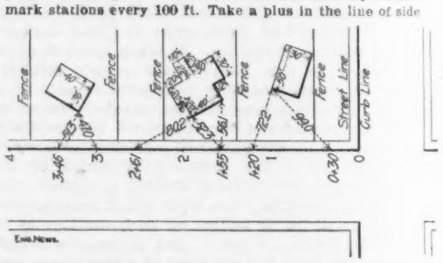
Also in removing gravel from the bar at Davis Island to boat on plank runways, horizontal distance 300 ft., vertical distance zero, 23,484 barrow loads equaled 1,228 cu. yds. by measurement, averaging 0.0546 cu. yds. or 1.47 cu. ft. per barrow.

Very truly, James H. Harlow.

Conowingo, Md., Sept. 11, 1905.

Surveys for Mapping the Location of Buildings on City Streets.

Sir: Replying to T. R. Ansit's request for methods of locating buildings on city streets, a method I have found sufficiently accurate and by far the quickest is as follows: Run a transit base line if necessary, but the curb line on paved streets is generally accurate enough for the purpose. Using the cross street curb line as o lay off and mark stations every 100 ft. Take a plus in the line of side



Method of Making a Survey for Mapping Buildings on City Streets.

of building produced and note distance to corner of building; then note distance to same corner from some other station or plus. The corner of the building and direction of one side are thus definitely fixed. The other sides are generally assumed to be at right angles.

P. Doddridge.

Cheneyville, Ill., Sept. 1, 1905.

Establishing Irrigation Canal Tangents So That Cut and Fill Will Balance.

Sir: Referring to the communication from "Tangent" in your issue of July 6, 1905, the following method of locating an irrigation ditch so that cut and fill will balance, will, I believe, be found useful in side hill work where the slope is practically uniform across the ditch.

Assume, for the present, the upper slope of the ditch to be the same as the outer slope of the bank. First find the depth of level cutting for which the cut will just make the fill. This level cutting is represented in the diagram by the line L—M. Through H, the middle point of L—M, pass any line A—F, representing the side hill surface.

We have, by construction,

area LBCK = area KMED.

Also, since A—B and E—F are assumed parallel,

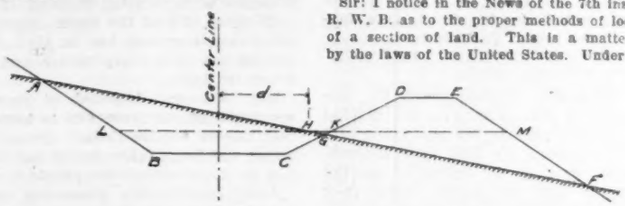
triangle ALH = triangle HFM.

Now, for the surface A—F, the cut is represented by the area ABCG, and the fill by the area GFED.

But area ABCG = area LBCK + area ALH — area HGK, and area GFED = area KMED + area HFM — area HGK.

∴ area ABCG = area GFED.

The distance d from the center line of the ditch to H the midpoint of the level cutting is readily calculated for any given cross-section of ditch and bank. The method of locating the center line in the field is, then, to run a falling contour for a center cut equal to the depth of level cutting represented by L—M and move each stake up the hill the distance d. After the line has been run out



in this way, the stakes will, of course, have to be "straightened in" so as to give a practicable alinement.

The above method may be modified to provide for shrinkage; and will still be of some service even where the upper slope of ditch and outer slope of bank are not the same.

Yours truly,

M. H. Wright.

512 Prudential Building, Atlanta, Ga., Aug. 26, 1905.

(Other replies to the inquiry made by "Tangent" were published in our issue of Aug. 10, 1905.—Ed.)

Sir: I have to thank your correspondents of Aug. 10 for the suggestions they have made regarding the establishment of tangents in canal work.

The grade percentage .4% was so evidently a slip of the decimal point that I did not think it worth while correcting it; of course 0.04% was intended.

In the matter of tangent versus contour alinement, a good deal can be said on behalf of each. The contour is doubtless the right method in easy country where curvature will not lengthen the line and the soil such as should not be trusted in fills, but in country where the contour looks like a plotted sine curve considerable strengthening has to be done and it is in this situation that the trial balance line shows its inadequacy.

Mr. Swain's method appears to be the most suited to rapid work (as it does not call for a transit line), especially if modification can be arrived at so that the quantities can be given positively. The shrinkage percentage would appear to me to make estimation by eye little more than guesswork; as some relation must exist between *center cut, slope of ground* and *"shy,"* a diagrammatic representation may be possible, establishing a definite basis for estimation.

As the question of alinement has other sides to it than the question of the disposal of excavated material, it may not be irrelevant to ask how it came to be the practice to adopt a grade contour location—has overhaul been found more expensive than maintenance when sharp curvature has been adopted?

Since seeing the letter by Mr. Wright (just preceding —Ed.), I have found that the method indicated by him is accepted by several as the most expeditious and that it serves all practical purposes when it is remembered that the shrinkage percentage varies somewhat.

I am, Sir, yours truly,

Tangent.

Canada, Sept. 9, 1905.

Establishing the Center of a Section of Land.

Sir: In reply to "R. W. B.'s" inquiry I wish to offer the following:

Under the provisions of the act of Congress approved Feb. 11, 1805, the course to be pursued in the subdivision of sections into quarter sections is to run straight lines from the established quarter section corners, United States Surveys, to the opposite corresponding corners.

The point of intersection of the lines thus run will be the corner common to the several quarter sections, or, in other words, the legal center of the section.

Yours respectfully, W. C. Nespital.

U. S. Engineer Office, St. Louis, Mo., Sept. 12, 1905.

Sir: Referring to the inquiry of "R. W. B." in your issue of Sept. 7, clearly, the only legal position for the center of an ordinary section of land (and by "ordinary" is meant one that is not rendered fractional by reservation or meander lines which intersect the quarter lines), is at the intersection of right lines joining the opposite quarter corners. And this without regard to how irregular the section lines may be.

A very clear explanation of the proper method of subdividing sections, together with legal authorities, is found in the pamphlet "Restoration of Lost and Obliterated Corners," published by the U. S. General Land Office. This is probably the highest authority on the subject, and the legislature of Minnesota, after over a quarter of a century of vain efforts to embody the same idea in a statute that would "hold water," recently abandoned the attempt to paraphrase and swallowed the pamphlet in toto—simply referring to it by name and date and making it the law of the state—an example which might be followed with profit by other public land states.

Very truly,

W. C. Smiley.

St. Paul, Minn., Sept. 9, 1905.

Sir: I notice in the News of the 7th inst. the inquiry of R. W. B. as to the proper methods of locating the center of a section of land. This is a matter which is fixed by the laws of the United States. Under the old common law the center of a section or other tract would have been so placed as to give each quarter its equal share of the entire area of the tract. In making the laws providing for the survey and sale of the public lands, Congress abrogated the common law so far as those lands are concerned and provided that the "lines not actually run and marked" by the U. S. Deputy Surveyors "shall be ascertained by running straight lines from the established corners to the opposite corresponding corners."

In applying this principle to the subdivision of the section, Commissioner Wilson, of the U. S. General Land Office, says, "The manner of subdivision consists of measuring straight lines from quarter section corners of a particular section to the opposite corresponding corners and the point of the intersection is the interior corner common to four quarter sections."

So far as I know no competent authority has given any different interpretation of the statute. That Congress meant to supersede the common law rule is plain from the fact that if they had not intended to do so they need not and would not have said anything about it. The fact that some of the quarter section corners were not accurately located has no bearing on the case. The statute makes no exceptions to the rule. In fact in the old compass surveys and in many of the later surveys there are very few of the quarter corners which are accurately placed for line and distance.

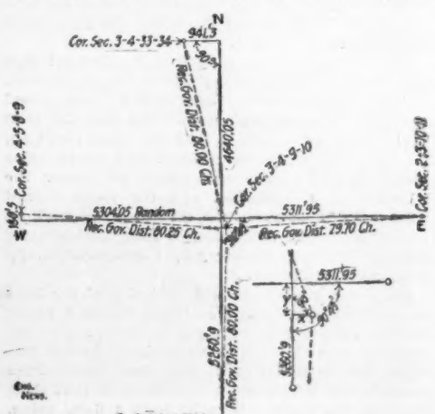
F. Hodgman.

Climax, Mich, Sept. 13, 1905.

Notes and Queries.

F. L. B., of Vulcan, Mich., desires an explanation of the principle of the Reflecting Circle (similar in action to the sextant, but having a full circle). In particular, what is the form and arrangement of the reflecting prisms used in this instrument, and what is the path of the ray?

A. Anderson, 22 Vernon St., Duluth, Minn., has a problem in surveying on which he asks advice: The section corner between Secs. 3, 4, 9 and 10 must be located from the four section corners next north, south, east and west. The recorded distances to these corners are: 80.00 ch. northerly, 80.00 ch. southerly, 80.25 ch. westerly, and



79.70 ch. easterly. A random line run north from the southerly section corner intersects a random line run westerly from the easterly section corner, at an angle of 90° 49' and at distances as noted on the sketch reproduced herewith. What short formula is available to compute the location of the desired corner from the intersection of the random lines?

L. W. F., of Connellsville, Pa., asks a large question in the following:

"Please give me a formula for calculating thickness of a pipe with external pressure, as a pipe under a fill."

The complexity of this question arises from the fact that a pipe under earth pressure is a special case of the retaining wall problem, but considerably more involved than ordinary cases of that problem. The following references to Engineering News bear on the question:

"Strength of 6-ft. Cast-Iron Pipe," W. P. Rice, 1896—I—342.

"Seven Mysterious Breaks in a 48-in. Pipe Line of the Boston Water-Works," F. I. Winslow, July 10, 1902, p. 24.

"An Example of Flattening of Large Cast-Iron Pipe Under Earth Pressure," W. W. Patch, Dec. 15, 1904, p. 547.

"Flattening and Cracking of Cast-Iron and Vitrified Pipe Under Earth Pressure," W. P. Snow, J. N. Hazlehurst, Jan. 12, Jan. 26, 1905, pp. 42, 99.

The letter of Mr. Hazlehurst above referred to contains formulas for the ring strength and the longitudinal beam strength of pipe under earth pressure, but nothing is said about the kind of fill over the pipe. When the distribution and amounts of the pressures on the outside of the pipe are known or assumed, the stress in the metal is not difficult to compute.

ANNUAL CONVENTION OF THE CENTRAL STATES WATER-WORKS ASSOCIATION.

The ninth annual convention of the Central States Water-Works Association was held at the Great Southern Hotel, Columbus, O., Sept. 12 to 14, 1905. The first session was a joint meeting with the Association of Boards of Public Service of Ohio and the Association of Fire Chiefs of Ohio. The session was called to order by Hon. H. O. Pond, President of the Association of Boards of Public Service of Ohio. Mr. Pond introduced Hon. George S. Marshall, Special Counsel, Columbus Law Department, who delivered an address of welcome in behalf of the Mayor.

Mr. Marshall paid his respects to the Ohio Municipal Code, which he held would greatly benefit the State. Mr. W. H. Ferguson, of Springfield, O., President of the Central States Water-Works Association, gracefully responded to the address of welcome.

J. T. Mertz, President of the Association of Fire Chiefs of Ohio, remarked that the passage of the Ohio Municipal Code giving to all cities of the State a uniform system of government had made it possible and desirable for public officials to meet in convention and discuss municipal questions, as under such uniform system of government like problems would be presented in all the cities, so that everything accomplished in any one city by way of a solution of such problems would through discussion in conventions benefit all.

THE MUNICIPAL IMPROVEMENTS OF COLUMBUS, O.

These were concisely and instructively described by Mr. Julian Griggs, City Engineer. The city is now engaged in many improvements. A minor one is the expenditure of $7,000 for enameled iron street signs with white letters on a blue ground. Some $200,000 has been expended recently in raising old flood protection levees for a distance of four miles and two miles more of levees are to be built to protect the new sewage disposal works. About $525,000 of street improvement work has recently been put under way or projected. The city has a larger mileage of brick pavements, Mr. Griggs stated, "than any other city." Important relief sewer work, 17 miles of sewers on the separate system and other notable sewer work has been done of late.

In November, 1903, the people voted $1,200,000 for sanitary sewage disposal, and in November, 1904, a bond issue of $1,200,000 for water softening and purification and accessory improvements was approved. Some particulars regarding progress on these great works will be given in a later issue of Engineering News.

A municipal electric lighting plant was put in operation early in the present year. Its generators are operated by steam turbines.

In conclusion, Mr. Griggs stated that future problems pressing for an immediate solution include the disposal of garbage and rubbish; the abolition of overhead wires and poles, and the elevation, on the West Side, of about 8¼ miles of railway of an indefinite and variable number of tracks, at a possible cost of $2,000,000, one-half of which, under existing laws, will fall upon the city.

PRIVATE AND MUNICIPAL OWNERSHIP OF WATER-WORKS.

The never-dying municipal ownership question was taken up by Mr. C. W. Wiles, of Delaware, O., and as ever interest was aroused. Frequently

under municipal ownership there is no charge for water used in fire protection and the like and as a consequence private consumers pay sufficient rates "to meet all these added expenses." If other municipal departments paid water departments for services rendered then public water departments would be on the same basis as private water companies, except for the necessity of making profits on investments. With as conservative and economical management as is shown by private companies municipal works would give the people "water at first cost and save the net profit."

During the discussion of this paper Mr. Chas. E. Rowe, Dayton, O., inquired whether the writer had made any investigation as to comparative sizes of water mains in municipal as compared to plants under private ownership, suggesting that private companies do not maintain as large-sized mains proportionately as do municipal plants, and consequently the expense of running municipal plants in that respect at least is proportionately greater.

To which Mr. Wiles replied that as a large proportion of plants municipally owned are located in the larger cities, the cost of the iron would be greater than in smaller cities, but that he was unable to furnish statistics along this line. He thought that as a business proposition a private company intending to permanently operate a plant would be foolish to put in smaller mains than the service required. In the plant he represented, with 21 miles of mains, the larger proportion are 8-in. and better, and these would be ample for a great many years to come. Mr. W. H. Boeh, Cincinnati, thought that the answer to the question would be largely governed by the age of the respective plants, since under modern practice larger mains are generally installed.

Mr. Boeh said that the Ohio Municipal Code did not permit the water department to charge other departments for water supplied to them for public uses. In some cases, therefore, a wastage of water resulted, because the other departments often found it cheaper to neglect to put in and maintain proper plumbing appliances, and thus allow the water to run to waste.

Mr. James, of Evansville, Ind., asked if the State of Ohio permitted its cities to waste water without furnishing to the water department authority to prevent the same. In his State, when water was being wasted, the department had the power to shut it off, whether for public or private use.

Mr. T. R. Cook, Toledo, O., thought that under the Ohio Code the water department of cities could charge other departments for water furnished for public use, and cited the cities of Columbus and Cleveland in support of his position. Much difficulty, however, had arisen in Ohio through differences in the interpretation of the Code by City Solicitors. He held that water departments can under the Code receive credit for water so furnished, and should do so. Mr. Cook claimed that the time was rapidly approaching when ideal civil service conditions would obtain in municipal water-works plants, and politics would not enter into their management, but would be divorced from them in the same way as has been the case with non-partisan police and fire departments.

Mr. Wiles stated that his paper was designed to show that municipal plants as a rule do not get credit for the water that they furnish for public uses, and he related a case where in one instance the school trustees not only used water free in the school buildings, but they actually hauled coal away from the pumping station on the ground that it was paid for by the city. However, this was no more unjust than to expect a water department to use up the coal to pump water for which they were given no credit.

Mr. A. L. Holmes, Grand Rapids, Mich., asked whether the interest on the bonds and the indebtedness of water-works plants was guaranteed and taken care of by the cities at large in Ohio. Mr. Boeh replied in the affirmative.

Mr. Rowe thought it was right and proper that the water-works should have proper credit for what they do. If in his city (Dayton, O.) they could get a return on the basis of a private corporation, the department would require very little in the way of bond issues, and could take care of its expense, interest and principal and also extensions and betterments. His department did not receive a cent in any shape for water furnished for public uses.

Mr. Wiles remarked that if they received proper credit they would not only be able to take care of the indebtedness, maintenance, extensions and betterments, but would also be able to give consumers water at the lowest possible cost.

THE NECESSITY OF METERING PRIVATE FIRE SERVICES.

Mr. W. H. Ferguson, of Springfield, O., discussed this question affirmatively. He divided manufacturers having private fire protection service into three classes: (1) The unscrupulous, "who deliberately, even to the extent of making secret connections, take the public water they need" without paying for it. (2) Those who defraud the public without intention, through thoughtlessness or "lack of reasonable appreciation of the rights in the case." These probably include the greater part of those who use water unfairly. (3) Those who use the utmost care to take no water for which they do not pay. The metering of private fire services is growing in favor, and the failure to collect the value of this service "is an injustice to other taxpayers." In conclusion, Mr. Ferguson said that "the city should own the meters instead of selling them to the consumers and charging double price for them" as is done in his city.

In discussing the foregoing paper, Mr. L. M. Latta, Akron, O., paid his respects very vigorously to consumers who use water through fire protection lines without paying for it. Mr. Latta's comments were almost sulphurous, and justly so, as he gave repeated instances where his company had been defrauded out of large values of water supplies. In many instances, however, he had by vigilant attention been able to discover and bring the offenders to time, in one instance collecting a bill of $1,900 for water illegitimately used.

Mr. Latta showed how it was possible to withdraw the wires from the ordinary lead seal used by the National Fire Insurance Association. Within the last 60 days he had seen a man go up to a sealed valve on a sprinkler system, pull the wires right out of the seal, open the valve and use the water, and then replace the wires so as to show no appearance of the seal having been tampered with.

Mr. Rowe explained why under the method of sealing employed by them the wires could not be withdrawn or tampered with without discovery.

Mr. H. J. Thompson, Hamilton, O., related a case where the key had been taken out of a wheel, the wheel lifted off the stem and the gate valve opened with a wrench.

Mr. Holmes related a case of a valve set in a pit outside of the railway power house grounds. It was a wheel valve, closed and a chain passed through the wheel and around the pipe and then locked with a padlock, so that the wheel could not be turned without the padlock and chain being removed. The stem was sawed off under the wheel with a hack-saw, and the valve opened with a Stilson wrench and the wheel set back on top of the stem, remaining in that condition for six months before discovery by a man accidentally jumping into the pit.

Mr. Latta stated that the majority of fire lines in his town are 6-in. He always places a meter on the same side that the run is, and puts a 6-in. by-pass around, with a valve both before and after the meter inside of the keys; then comes around with a by-pass in the center of that right opposite the meter where he puts a 6-in. valve. The whole is set in a concrete bed with a 24-in. manhole on top, so that it is easy to get into. The valve on the by-pass is closed. If anything happens to that meter the cover can be taken off the manhole and the by-pass valve opened. The meters are read every other morning like clockwork, whether Sunday or any other day. In one case where a consumer protested his bill and claimed there was a leak somewhere, by showing the consumer the variable meter readings from day to day, it was evident that this was not due to leakage, which would have been a more constant quantity. He was thus enabled to collect the bill without further difficulty.

Mr. M. J. Breece, Galion, O., inquired how under the above construction it could be ascertained whether the consumer opened the by-pass, to which Mr. Latta replied that they were at the mercy of the consumer to that extent, not wishing to lock the by-pass valve for fear of fire. Mr. Latta said that all of his meter readers are instructed to have some member of the family go with them to read the meter, not only to see that the meter is correct, but for their own protection. Meters are read every month and bills rendered every 60 days.

Mr. Thompson inquired of representatives of municipal plants present as to how many of them had meters on fire lines. He said that enough water was being taken out of such lines at Hamilton, O., to drown all the people in Columbus.

After considerable discussion on this general subject, President Ferguson referred to the fact that it had been thoroughly gone over at the May meeting of the American Water-Works Association. He then read a description of the Hersey detector meter, in part as follows:

DETECTOR METER.—This device is to be known to the trade as the "Detector Meter." Its object is fairly indicated by its name, viz., that it will measure accurately all drafts, say up to 150 gallons per minute, and that it will detect and exhibit whether or not any additional quantity in excess of this amount has past the device.

Broadly stated, this meter consists of an indicating detector check valve on the main fire line and a meter on a by-pass around the detector. There is no mechanism on the main fire line except the detector—a device which possesses no appreciable resistance, but which, on the other hand, always presents an unrestricted waterway for use in case of fire.

What the detector does is, (1) to cause all drafts up to about 150 gallons per minute to go around through the by-pass meter, where they are all measured; (2) to give a positive indication that, while this is going on, no water is passing through the fire line; (3) to give a positive indication if the draft exceeds 150 gallons per minute and just how many hours such an excess has been going on. It may even be made to indicate just when it took place.

THE AIR LIFT FOR DEEP WELLS.

At the same convention four years ago Mr. John Langan, of Tipton, Ind., read a paper on the air lift pump. The present paper continued his experiences with that device during numerous experiments. Increased efficiency was gained, but more wells had apparently become necessary after some five years. At this juncture a form of air lift devised by Mr. Walter B. Harris, of Indianapolis, Ind., and made by the Harris Air Pump Co., was tried, increasing the yield of a 6-in. well, 280 ft. deep, from 40 to 150 gallons a minute. The latter rate has been continued to date. Mr. Harris being called on for remarks stated that his air lift is constructed on entirely different lines from any heretofore known. Under the old practice, he said, it required 60% submergence to pump water with air; in other words, 2 ft. of water for 1 ft. of lift. With a well 100 ft. deep, with static head, say, of 50 ft., you could not carry to exceed 24 lbs. of outer pressure, which will raise a column of water on the discharge side of the machine 48 ft., which will give you a false submergence, making your static head 98 ft. It also acts as a cushion upon the water, forcing the water in the discharge side under pressure, thereby making no provision for air to be discharged when delivered to the machine proper. These two pressures, the in and out pressure, co-operate, and you get a third action, that of suction, which is produced by the discharge of air through the inner tube. These three pressures co-operating comprise an automatic system with a very small consumption of air.

THE PREVENTION OF WATER WASTE.

A paper on "The Prevention of Water Waste" was read by Mr. A. L. Holmes, of Grand Rapids, Mich. Speaking of municipal administration, he said some features of it "would look mighty queer to the Rockefellers and other successful managers of ordinary affairs in the commercial world." This is notably true of public water supplies, which every one must patronize, but why, Mr. Holmes asked, "do we find so many of the municipal plants unprofitable to the towns that claim to own them?" The answer may be found in the pumping statistics of various cities. These show per capita consumptions of from 50 to 250 gallons a day, in many cases under apparently similar local conditions as regards manufactories and the like. Invariably the city with the lowest per capita pumpage will be found to be metering its supply. Instances of the effective use of meters were cited in some detail. In contrast it was

shown from figures of metered consumption in Grand Rapids that the large percentage of unmetered services are apparently responsible for water waste costing $12,712 a year for coal alone. One of the small cities referred to cut its July water consumption from about 33,000,000 gallons in 1901 to 9,450,000 in 1904, the services having increased meanwhile from 516 to 580 in number.

During the discussion of the paper Mr. Latta inquired what, if any, difference the introduction of meters in the town referred to had made in the income of the plant. Mr. Holmes replied that their revenue at 17½ cts. per 1,000 gallons was increased during the fourth year about 25%, and he believed that similar results would follow the introduction of a fully metered system in any other town.

GENERAL FEATURES.

During the convention visits to the new sewage disposal works and other points of interest were made and there were some tests of fire towers and the like. There were present at the meeting 23 active and 43 associate members.

Cincinnati was chosen as the next place of meeting. The following were the principal officers chosen: President, C. J. Thuman, Evansville, Ind.; Vice-President, A. W. Inman, Massilon, O.; State Vice-Presidents, John Langan, Tipton, Ind.; W. H. Glore, Covington, Ky.; T. H. Morton, Nashville, Tenn.; A. L. Holmes, Grand Rapids, Mich.; Wm. Schwertfeger, Wheeling, W. Va.; Secretary, Wm. Allen Veach, Newark, O.; Treasurer, Chas. E. Rowe, Dayton, O.

THE WATER SOFTENING PLANT AT OBERLIN, O.

An interesting paper on what appears to be the only municipal water softening plant in the United States was read on Sept. 14, 1905, before the convention New England Water-Works in New York, by Mr. W. B. Gerrish, of Oberlin, O. Surface water from a storage reservoir is treated with soda and lime, given a long period of sedimentation, and then passed through mechanical filters of the pressure type. Pressure filters were adopted, it appears, in order to make the existing pumps suffice. These pumps deliver water to an elevated water tank. The average daily water consumption at Oberlin is only some 165,000 gallons a day.

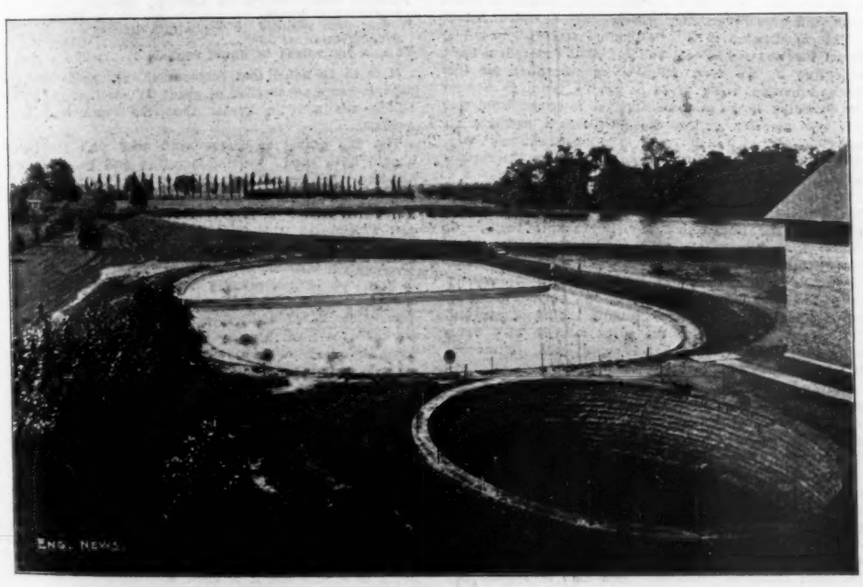
Mechanical agitators, driven by a Pelton water motor, are used in both the soda and lime tanks, the power water being subsequently used for preparing the lime water. The box for mixing the two chemicals is of steel, 2 × 2 × 40 ft., with baffles; it is water tight and under pressure. The chemically charged water from the mixing box enters the bottom of the first settling basin through an 8-in. galvanized iron pipe, 40 ft. long, pierced by a row of 1-in. holes 6 ins. apart. A floating arm draws off the water from this basin and passes it on to a distributing pipe in the second basin, similar to the first distributor, except that the perforations are of ⅞-in. diameter. A float arm removes water from the top of the second basin, also. Each of these basins has a capacity of 330,000 gallons.

During the past year from 17 to 6 grains of lime and from 6 to 2 grains of soda per gallon of water were used. The alkalinity was reduced from about 10 to about 3 grains per gallon. Although not designed primarily for bacterial effect, yet in selecting the softening and filtering process it was borne in mind that being a surface supply the water is open to possible contamination. Bacterial tests during 15 days in November and December, 1904, showed an average of 371 bacteria per cu. cm. in the storage reservoir, 37 in the first basin, 13 in the second basin and less than five, on the average, in the village supply. This is a removal of 90% by the first settling basin alone, and of about 99% by both basins and the filter. (The reduction is the more notable because of the low number of germs in the raw water.—Ed.) B coli tests made on five days in December, 1904, were in every case positive for the raw and negative for the filtered water.

The cost of chemicals at Oberlin is about 1 ct. per 1,000 gallons of water treated. Allowing 1½ cts. for labor and for capital charges the total cost of treatment is about 2½ cts. per 1,000 gallons.

Low water consumption during August of the present year permitted tests which showed "that to produce the best results there should be about six days of sedimentation before filtering."

About once a week the holes in the chemical distribution pipe in the first basin have to be cleared of a hard deposit, which in six weeks would otherwise choke them completely. The holes in the second basin would be filled in about six months. The precipitate in the first basin amounts to about 1 ft. a month and in the second basin to about 4 ins. in 20 months. The deposit is discharged into a creek by gravity. Mr. C. Arthur Brown was credited by Mr. Gerrish with the general plans for the work.



STORAGE RESERVOIR, SETTLING BASINS AND PUMP WELL, OBERLIN, O.

(The settling basins are in the center, and were formed by building the central wall shown across an old reservoir.)

FULL MUNICIPAL OWNERSHIP OF WATER-WORKS at Niagara Falls, N. Y., has been recommended by the board of public works in a report to the common council of that city. At present there are two plants, one owned by the city and one by the Niagara Falls Water-Works Co. The acquisition of the latter plant by condemnation proceedings is proposed; and also additional filters and pumps.

PROGRESS ON THE SEWAGE WORKS AND WATER SOFTENING AND PURIFICATION WORKS OF COLUMBUS, OHIO.

After years of shameful dilly-dallying, the city of Columbus, O., recently entered upon an era of public improvements rarely equalled by an American city. Besides the sewage and the water purification works noted below, these improvements include flood protection, street paving, sewer extensions, an electric lighting plant, and a concrete dam to form a large storage reservoir on the Scioto River. A paper describing these improvements was presented before a joint gathering of various municipal organizations, including the Central States Water-Works Association, held in Columbus, Sept. 12 to 14. A brief abstract of the paper, which was by Mr. Julian Griggs, City Engineer of Columbus, is presented in our account of the convention of the Central States Water-Works Association elsewhere in this issue. Fuller particulars of the sewage and water purification works are abstracted herewith, as follows:

SEWAGE DISPOSAL.

In November, 1903, the people voted $1,200,000 bonds for the purpose of sanitary sewage disposal, and under this authorization the council by recommendation of the board of public service voted an appropriation of $46,000 for experimental work, to determine the best method of sewage purification under Columbus conditions. This preliminary work began about one year ago, and has just been completed. The report is in preparation and will be published later.

Plans of the sewage purification for a nominal flow of 20,000,000 gallons per day have been presented to the State Board of Health. These plans propose septic tanks followed by sprinkling filters. The septic tanks will be 12 ft. in depth, uncovered, and will have a capacity of about 8,000,000 gallons. The sprinkling filters will be about ten acres in area of broken stone, 5 ft. in depth, laid on hollow free-draining bottom, with sprinkling nozzles 15 ft. c. to c., designed under a 5-ft. head to spray the septic sewage over the surface of the broken stone, at a net rate of 2,000,000 gallons per acre per day. The effluent from these filters will be collected in settling basins with a capacity of 4,000,000 gallons, and our experiments show that a non-putrescible effluent can be thus obtained.

The detail plans for the sewage purification works above noted are in course of preparation, but a large amount of preliminary work leads up to the sewage purification, which is the last step in the construction of the disposal works. The preliminary work consists of the sewage pumping station which is designed to pump the sewage of the city to the sewage purification works, and, in times of flood in the Scioto River, to pump the storm water to the full extent of its capacity, 41,000,000 gallons per day, from the low-lying area of the Scioto River. The machinery of the sewage pumping station will consist of three 11,000,000-gallon and two 4,000,000-gallon centrifugal pumps.

The station complete, including the screen cages, machinery and building will cost about $130,000. In order that the pumps may be effective for the storm water, a levee has been constructed around the station and on the west side of the river for a distance of two miles, and in order to supply coal for the station when in operation, and material for the works under construction, a railway track upon an embankment about 17 ft. high has been constructed from the Hocking Valley Railway across the river, and is projected for a further distance of 1¼ miles to the sewage purification works.

It has been necessary to extend the intercepting sewer by a 48-in. cast-iron pipe under the river to the pumping station, and construct a force main of the same dimensions 1¼ miles in length to the purifying works.

A 10-in. water main from the distribution system of the city has also been extended to the purification works, parallel with the railway track and force main above noted.

Contracts for the work preliminary to the purification of the sewage under contract for completion during 1905 amount to $460,000; and includes the pumping station with its machinery, screens, gates, valves, the force main, water main, ditches, levees, culverts, railroad bridge, track and embankments as above noted; to which should be added $96,543 for 422 acres of land for the disposal works.

In addition, the plans require two pumping stations on the Alum Creek sewer in the eastern portion of the city, to raise the sewage to the ridge east of the Scioto River, from whence it will flow by gravity to the main sewage pumping station.

WATER SUPPLY.

The water supply, works for which were first installed in 1871, is derived from wells and underground conduits; supplemented in times of scarcity by direct intake from the Scioto River and Alum Creek, upon the banks of which the pumping stations are located. The eastern, or Alum Creek station, derives its supply from driven wells

and furnishes about 6,000,000 gallons per day. The west side station is located near the junction of the Olentangy and Scioto rivers and has about 2½ miles of underground conduits of brick or iron construction, 42 ins. in diameter, located from 15 to 30 ft. below the general surface of the river valley, or about 10 ft. below the bed of the river, beneath which it crosses in several directions. The water derived from the underground supply is healthful, but has been inadequate to the needs of the city and has constantly been supplemented by direct intake from the streams from the time of its installation to the present, producing among its users a high typhoid fever death rate.

The question of additional supply has therefore been frequently considered, and as the result of much study and reports by experts, the Scioto River has been recommended as the most available source. About one year ago a contract was let for the construction of a dam across this stream, 6½ miles above the west side pumping station. The dam is now something more than half done, is of concrete, 1,000 ft. in length, 64 ft. in width at its base, with an overflow weir in the center of 500 ft., the crest of which is 33 ft. above the apron, 46 ft. below its deepest foundation, and has abutments on each side 22 ft. higher than the weir.

The reservoir formed by this dam will be six miles in length, about 490 ft. in average width, and will impound 1,627,000,000 gallons of water. This construction has required the purchase by the city of 472.323 acres of land, at a cost of $139,082; has required the relocation and reconstruction of about three miles of turnpike, at a cost of $45,000, together with the reconstruction of the highway bridge over the reservoir, estimated to cost $90,000. The bridge is to be erected by the county, and of its cost the city will pay 70%.

The recommendations of the State Board of Health and all of the consulting engineers employed, was for a dam which would raise the water 52 ft., creating a reservoir ten miles in length and storing 5,000,000,000 gallons of water. The present construction is designed with the view of a subsequent addition to the volume of the masonry which will ultimately realize the plan which has been recommended.

Water power development in connection with the dam was also recommended, but nothing in this direction is now being done except the placing in the present construction of three power tubes for such future use, whenever desired. The total cost of the Scioto River storage dam and reservoir will approximate $770,000.

WATER SOFTENING AND PURIFICATION WORKS.

In November, 1904, at a general election, a bond issue of $1,200,000 was authorized for the water softening and purification works. Plans have since been prepared and this work put under contract in June, 1905, at an estimated cost of $524,000. These works are located on the north bank of the Scioto River, a mile above the west side pumping station. Eighty-eight acres, at a cost of about $900 per acre, were purchased for the site. The plans include a track connecting with the Pennsylvania Railway for the delivery of construction and operating material. The softening and purifying works themselves occupy an area approximately 500 × 800 ft., or about ten acres, and consist of a headhouse, lime saturating tanks, mixing tanks, a settling basin in six compartments of 15,000,000 gallons capacity, ten mechanical filters of a nominal capacity of 3,000,000 gallons each, and a clear water reservoir of 10,000,000 gallons, together with bacteriological and chemical laboratories. Construction on this work has been in progress for about two months and is under contract for completion Nov. 15, 1906.

The construction of a conduit from the storage dam to the purification and softening works, estimated to cost $472,000, will be postponed for reasons of economy, and the water be permitted to flow down the channel of the river. The supply for these works will therefore be taken direct from the Scioto River adjacent by means of two low-lift centrifugal pumps of 20,000,000 gallons capacity each.

The pumping station will also be equipped with two vertical triple expansion, 20,000,000-gallon pumping engines. The machinery for the pumping station, including boilers, is estimated to cost $285,000, and bids for the same are (were—Ed.) to be received on Sept. 14, 1905.

THE USE OF OIL ON MACADAM ROADS AND OIL-ASPHALT STREETS IN CALIFORNIA.*

By Theodore F. White.†

The oiling of roads and streets in California first began to attract particular attention about six years ago, when petroleum oil was used in Los Angeles County in a small way in 1898 and more in 1899, followed by San Bernardino County in 1899, when the writer was a member of the Board of Supervisors of that county, and by virtue of his office one of the Road Commissioners.

The first use of oil on roads had for its object the laying of dust, which was almost unbearable during the long dry summers of California. It was used for this purpose instead of water, sufficient quantities of the latter being difficult to obtain in some sections, and it was thought that the oil would have a more lasting effect, and so be more effectual and economical for this purpose. It was found to be an excellent dust layer. All grades of oil were used, from high gravity, containing but a small quantity of asphaltum and charged with water and sediment, to heavy oil, free from water, and very rich in asphaltic base. No attempt was made in the beginning to obtain a hard, smooth-surfaced road. The idea was to mix the oil with the natural loose surface dirt of the road, in sufficient quantity to make it heavy, so that the dust would not rise. It was thought that it would be a waste of material to use oil on a loose sandy road, that it would simply sink into the sand and disappear, and if used on a hard surface like macadam it would not penetrate but run off into the gutters. Even the parties who claimed to be the discoverers of this use of oil, and to have a patent on its use (but who have never been able to substantiate their claims), said that there must be a loose covering of at least an inch in depth on the road to mix with the oil.

One of the first things to be noticed was that the larger the percentage of asphaltum in the oil, the firmer it made the surface of the road, and so the better the results. Another was that if the oil was worked in deep, especially in a clayey soil, it made a spongy roadbed that was very heavy for hauling over, and that the oiled layer became rutted and ridged and very uneven. There are miles of just such roads in California to-day. Teamsters condemn them, and they are very unsatisfactory, on account of their unevenness, even for light rigs. It was found that sandy and gravelly surfaces absorbed the oil readily, and became very hard if a heavy asphaltic oil was used; that even loose drift sand, while it took a large quantity of oil, put on in a number of applications and considerable time to set and harden, could be converted into a smooth, hard-surfaced roadbed. But an absorbent, hard compacted gravel surface, it was found, made an ideal oiled road, when a heavy asphaltic liquid was used. This led up to the use of this kind of oil upon macadam roads; and now we are building, what we call "liquid asphalt" roads and streets, giving careful attention to all details of carefully preparing the sub-grade, putting down the crushed rock layers, filler, etc., and thoroughly compacting this base to a hard, smooth, properly shaped surface, to receive the oiled, or rather asphaltic, covering, and obtaining a result that is very similar to the regulation asphalt pavement—hard, but not quite so hard and smooth as the latter, but furnishing a better footing for the horse. A surface that does not get slippery in wet weather, a surface that is slightly elastic, very pleasant to travel over, and which effectually preserves the macadam below.

The construction of this "asphalted macadam" road or street involves the careful building of the macadam base, according to the most approved specifications for this work, attention being given to proper drainage and to the crowning of the surface. It must be remembered that this base supports the load that goes over it, and that the superimposed asphalted layer is a comparatively thin, slightly elastic, protective covering that takes the surface wear.

The macadam base in this climate is made from 4 to 6 ins. in thickness, according to the firmness of the subgrade and the load which the road has to carry. It should have a cross section that will insure the storm water reaching the gutters soon after it falls; and the surface should be smooth and even, without depressions. Catch-basins on the surface, where the water will stand, would be a very serious defect in this kind of roadbed. The constant travel over the spots covered with water would cut through the surface layer, and, unless repaired, a hole would form.

Granite, trap and limestone are commonly used in this macadam. A dense limestone is excellent for this purpose. It can be compacted into an unyielding base without voids, while the asphalted layer protects it from the abrasion of travel.

After the macadam base has been carefully prepared, the most approved plan for putting on the liquid asphalt covering is as follows: The surface of the base being free from all debris or loose material, clean, smooth and hard, a thin layer, ¼ to ⅜ in. thick, of fine angular gravel, or coarse, sharp, clean sand is spread upon it, evenly and of the exact thickness required. Upon this is applied the liquid asphalt or heavy asphaltic oil, put on at a temperature of not less than 150° F. and in quantity 3-5 to ¾ of a gallon per sq. yd. The liquid is likewise put on by a machine that spreads it evenly over every particle of the surface, and in the exact quantity required. It is desirable to let the liquid remain for at least twenty-four hours without being disturbed, under the warm rays of the sun, that it may penetrate the base as far as possible, to secure a good bond between the base and covering. Then another thin layer of the sand or gravel is spread over the surface, and a second application of the hot liquid is put on like the first from 2-5 to ½ gallon per sq. yd. This is followed by a third layer of the sand or gravel, sufficient to completely fill the liquid with grit and leave no stickiness upon the surface. Sometimes a plank "smoother," 6 ft. long, made of 2 × 8 or 2 × 10 ins., hard wood plank, put together ship-lap fashion, is run over the surface lengthwise, crosswise and diagonally after the second application of the liquid, before the third sanding, if the liquid does not pick up, but after the third sanding, if it does, to more thoroughly mix and pulverize any large particles of the gravel layer. If the "smoother" is run over the surface after the third sanding or sanding then another light sanding is put on after the smoothing. This is to prevent particles of the oiled layer, while it is still "green," from adhering to the wheels of vehicles or to the feet of horses traveling over it.

As soon as the last layer of gravel or sand is put on, a light or medium weight roller may be run over the surface and the road or street may be thrown open to travel. If the travel on the street is considerable the rolling just previous to throwing it open may be omitted. After the street is so thrown open, should any "wet spots" develop from there being an excess of the liquid, a little more sand should be put on, just sufficient to take up the liquid and remove all stickiness.

After the street has been traveled two or three weeks, should the surface not be entirely smooth, then a medium weight roller, say 2,000 lbs. to the foot-width, may be run over it with much benefit to iron out the unevenness and little creases made by travel. This rolling may be repeated at intervals of two or three weeks for a number of times during the hardening process, but it is frequently omitted altogether. The travel, if considerable, will work the surface down smooth, but the rolling will make a better-looking job. The result is a smooth, firm, rubbery, asphaltic surface, that continues to harden for some months after the work is done until it becomes as hard and almost as smooth as an asphalt pavement. In fact, it is an asphalt pavement, but got at a small fraction of the cost of the regulation pavement made with hard asphaltum.

The asphaltum being used in liquid form on the macadam, as above described, takes much longer to set and harden than in the pavement, where the "D" grade asphalt is used. On the other hand, the liquid asphalt is not injured by a high degree of heat, as sometimes happens in reducing asphalt to the hard form. It has, therefore, a longer life and more elasticity after it does set and harden than some of the hard asphalts.

The liquid used to secure the best results has a gravity of about 10.5° B., and contains over 80% of "D" grade asphaltum, over 90% of asphaltum in liquid form, and comes from what is called the "Sunset" Fields, near Bakersfield, California. A sample of this liquid recently submitted to a careful test showed as follows:

Gravity, at 60° F.	10.3 degs. B.
Water	None.
Volatile, when heated to 400° F. for a period of 10 hours	17.2%
It was then reduced to asphaltum having a penetration of 55°	82.8%
This is equivalent to liquid asphalt	90.0% plus.

It is to be noted that commercial "D" grade or hard asphalt has a penetration of about 60°, so that the above 82.8% was a little harder than the commercial hard asphalt.

The fine gravel or coarse sand used with the liquid should have good wearing qualities and be sharp and angular. The nearer it is to pure silex the better. The idea of the liquid-asphalt-gravel surfacing is that the asphalt is simply a slightly elastic cement to hold the grit with which it is filled together, to make a durable wearing surface and protect the supporting base below. In building a street as above described, after the base is prepared, it is absolutely necessary to keep travel off the portion being treated with the liquid. If the street cannot be closed altogether, then one side should be worked at a time, keeping the travel off this until it is finished, ready to throw open to the public, before the other is undertaken.

It may be pointed out that our experience with this class of roads and streets has heretofore been mostly in the climate of California, and they have been built during the summer season, when it is dry and warm. It is important that the surface of the base be dry, and better warm, when the liquid is applied; otherwise a good bond will not be secured and the covering will be inclined to peel off. It is therefore suggested that in building such a road in a climate where there are frequent rains, that the liquid be put on during a warm, dry period, when rain is not liable to fall during its application. After the liquid is spread and it is filled with gravel or sand the rain will do little harm.

Examples of asphalted-macadam roads and streets can now be found in a number of places in California. Probably the first was built by the writer and a fellow-member of the Board of Supervisors of San Bernardino County, between the city of San Bernardino and Colton, in 1900. Riverside now has miles of streets so covered that are noted for their excellence. Los Angeles has lately adopted specifications for this class of work, and other cities and towns are following suit.

*A paper read at the Montreal Meeting of the American Society of Municipal Improvements.

†Member Advisory Committee National Good Roads Association.

THE LOS ANGELES WATER SUPPLY SCHEME noted in these columns a few weeks ago has been sanctioned by the voters to the extent of a $1,500,000 bond issue to begin proceedings. The scheme calls for a conduit from Owen's River, 240 miles in length, and for a total estimated expenditure of $2,300,000.

MOSQUITO EXTERMINATION IN THE UNITED STATES.

Mosquito extermination work in the United States was reviewed at the annual convention of the American Society of Municipal Improvements at its Montreal convention, Sept. 5 to 9, 1905, by Mr. Edward Rankin, of Newark, N. J., Chairman of the Society's Committee on Sewerage and Sanitation. In the discussion following the review an interesting account of extermination work at Mobile, Ala., was presented by Mr. Hazlehurst, of that city. The work at Mobile is of interest because it was designed to prevent an invasion of yellow fever and because thus far the city has been free from that disease. Some information from Mr. Rankin's review and nearly the whole of Mr. Hazlehurst's remarks follow.

THE ANTI-MOSQUITO CAMPAIGN.

In his opening remarks Mr. Rankin stated that it is now established beyond question that yellow fever is carried by the Stegomyia and malaria by the Anopheles mosquito. Since all species of mosquitos require water for one stage of their development, extermination lies in filling or draining swamps, marshes and stagnant pools and the avoidance where possible of cesspools, cisterns and rain barrels. Where other means fail, resort must be had to screening or oiling standing water or else stocking it with fish.

Mosquito extermination work is now being carried on in Massachusetts, Connecticut, New York, New Jersey, Delaware, Maryland, Florida, Alabama, Louisiana, Texas and California, and possibly elsewhere in the United States. New York City has appropriated $17,000 for dealing with salt marshes on Staten Island and has filled in some breeding places on Long Island. The health departments of New York and Stamford, Conn., and the Village Improvement Society of South Orange, N. J., have issued circulars giving specific instructions for mosquito extermination work by citizens. The State Legislature of New Jersey first appropriated $10,000 for the study of the extermination problem by its State Entomologist* and later it authorized local boards of health to condemn as nuisances all mosquito breeding places and to cause their abatement. A still later New Jersey Act appropriated $16,000 for mosquito work, of which $6,000 is for investigations and $10,000 for the co-operative drainage of salt marshes, the State to pay 25% and the municipality 75% of the cost.

The city of Newark, N. J., expended $5,000 in 1904 in draining a portion of the Newark meadows. The city of Elizabeth spent $1,000 in like work in 1904 and during the current year it has devoted $2,000 more to the work and thus gained $500 from the State in addition.

Mr. Rankin spoke of the work of the American Mosquito Extermination Society, the work of the United States in freeing Havana, Cuba, from yellow fever by a crusade against mosquitos and referred to the work now going on at New Orleans.

MOSQUITO EXTERMINATION WORK AT MOBILE, ALA.

Mr. J. N. Hazlehurst, M. Am. Soc. C. E., Chief Engineer of the Board of Public Works at Mobile, Ala., spoke at length on the work done under his direction. His remarks, except for slight condensation, were as follows:

To-day Mobile is surrounded by yellow fever on all sides—Pensacola, Natchez, Vicksburg, New Orleans, all have the yellow fever. Shortly after the outbreak in New Orleans there was a mass meeting called in Mobile, which was very largely attended, and which determined to watch the mosquito, believing firmly in the theory that the stegomyia family were the propagators of the fever.

The organization that was formed that night undertook to finance a battle against the mosquito, and determined to raise the amount that was required, about $15,000. There was also a committee on education and an executive committee appointed. The citizens did me the honor of appointing me as superintendent of the executive committee.

Our city comprises about a hundred miles of streets. Its topography is very flat and low. The main difficulty with us is a want of drainage. We have only a few sewers in the town, and a great many of our outlying districts have only surface ditches. These being cleaned out from time to time the loose loam soil has been thrown up alongside, and in many cases the lots are higher than the street. So, after our heavy tropical rains whole sections are sometimes inundated, and a great many houses of the poorer classes, particularly, and in the negro quarters are surrounded by ponds of water which generally lie there till they evaporate.

The city was divided into eight districts, and a detail of police was appointed by the mayor, to be under my supervision. This detail consisted of eight men, one for each section. Each of these men had an assistant, and it was their duty to make a house to house canvass and inspection, and report on the sanitary condition of the premises in general, and to mention specially anything in the way of water leaking from cisterns or unsanitary plumbing in the houses. They also reported whether the lot had any water standing on it, and the amount of weeds that covered the ground, and whether they had grown to any height.

Those men had instructions to correct any minor details that they came across, without reporting them. By minor details I mean such things as turning over cans, tubs and barrels having stagnant water in them. The officer also had with him circulars which we had printed for the purpose and which he had to distribute them. These read as follows:

YOU ARE EXPECTED TO HELP IN THE WORK.

Q. What work?
A. Destruction of mosquitos.
Q. What is that for?
A. To protect every citizen and every occupant of Mobile, his life and health, business or employment not to speak of the future prosperity of the city.
Q. How is that connected with mosquitos?
A. Well, it is just this way: Yellow fever has a start in New Orleans. The authorities are doing everything in their power to keep any one from coming in here who may have a yellow fever in his blood. But, if notwithstanding the good quarantine system, such a person should come in here yellow fever could not spread except for the domestic mosquito. This mosquito has to suck up the blood of a yellow fever patient, which blood contains the germ of yellow fever. After twelve days these germs have grown in the mosquito's poison sac, so that when it bites anyone it passes the yellow fever germ into the person's blood. So you see we must get to work and prevent this.
Q. How are we going to do it?
A. Well, let's all help make quarantine effective, and not leave all the detective work to the authorities, so we can send quarantine violators to a safe place at once. Let's cover all fever cases with mosquito bars till the doctor tells us what the disease is.
Let's kill mosquitos where they hatch, kill others wherever we can. In short, here are the

RULES FOR EXTERMINATION.

(Keep these rules where you can see them).

(1) Put fine netting over cisterns, wells and tanks of water required for every day use, and put layer of kerosene on surface of the water.
(2) Dump all standing water that has collected on the premises in accidental receptacles, such as vases, barrels, tubs, stopped-up roof gutters, etc.
(3) Change often the water needed in barns, chicken coops, kennels, etc.
(4) Drain or fill in all pools or hollows on premises likely to collect rain water.
(5) If wrigglers are found to exist in water required for every day use, as in barrels, cisterns, etc., cover with a thin layer of petroleum or kerosene, half a tea cup to every 15 ft. of surface. If the odor of these oils is objectionable oil of eucalyptus may be substituted where expense is immaterial. Note increase of malarial and other fevers two or three weeks after a rainy spell: mosquitos are the cause.
(6) Kill grown mosquitos in dwellings by fumigating with sulphur, formaldehyde or pyrethrum (Persian insect powder). The pyrethrum (insect powder) should be moistened into thick paste and dried in or under the stove. It will then burn and smoke without difficulty. The mosquitos will be stupified and fall to the floor, when they may be easily swept up and destroyed. Burning pyrethrum powder out of doors will keep mosquitos away from the immediate vicinity.
(7) Remember, you owe it to your neighbors as well as to yourself and family to prevent the breeding of mosquitos on your premises. Examine your lot, and house carefully at least once a week. If you find wrigglers in any water on the place you are raising a crop of mosquitos that will be a source of annoyance and danger to the neighborhood.

THE AUXILIARY SANITARY ASSOCIATION OF MOBILE.

This pamphlet was distributed by the thousand, and the officer was directed to notify each tenant or each inhabitant of the danger of having standing water on his premises, or leaks in the sewer service, or leaks in the water service, or high weeds. As soon as any reports were received they were turned over to the police chief, the superintendent of water-works, or the superintendent of sanitary plumbing, and there were specific orders from the mayor that they should begin immediately to correct those defects.

The eight men for the sections had five laborers with them and one cart, and they were supplied with oil and lime, and they were given general directions to go to the houses that had been reported by the officers and to correct the trouble that had been reported.

In many instances it became necessary to drain the ditches to get rid of the water under the house.

We adopted a pretty large and broad plan in cutting the weeds. We started three two-horse mowing machines in the lots where the weeds were growing high, and where the tenants were poor and could not cut the weeds themselves. We thought it better to do the work ourselves than waste the time trying to force them to do it. We also employed five men with scythes where the machines could not go.

While it is true that probably the weeds have not any effect upon the mosquito, still we look upon them as a collateral. We found that the tall, rank weeds were a roosting place, if I may use the expression, for the mosquitos, and when the scythes went through them the mosquitos could be seen coming out in flocks. We also found that when we cut the weeds it would give the wind an opportunity to get at the pools and they would be evaporated much sooner, and we got rid of a good many standing pools in that way.

Besides the eight gangs whose duty it was to clean up the premises we put a gang out oiling open pools and ditches. This gang consisted of a foreman and two laborers. It was provided with a cart, a force pump and a sprinkling machine.

The oil we used was crude petroleum mixed with kerosene. We found that the Beaumont oil was a little too heavy to spray properly, but when it was mixed with kerosene we found that it sprayed very well, and made a good surface over the water. We also used a by-product of wood tar, called "pyro-creosol," and found it to be a good insecticide when placed in the water.

We are still keeping up the fight, which has been successful so far, although we are peculiarly situated in Mobile. We have a large export trade with many southern ports. We have steamers coming from the Bocas del toro and Port Lemon, and have as many opportunities of bringing the fever to us as perhaps any other place in the district.

At the time I left our payrolls were running about $1,000 a week, and our supplies were costing about $350 a week. Crude oil costs us 6 cts. and kerosene 8 cts. a gallon.

(*Dr. John B. Smith, New Brunswick, N. J. An exhaustive report on the subject has been published under his direction. The New York State Entomologist (Dr. E. Porter Felt, Albany, N. Y.) has also issued a report on "Mosquito in Culicidae of New York State."—Ed.)

FOURTEEN SUBMARINE TUNNELS are now under construction or under contract to connect Manhattan Island with New Jersey on the west or Long Island on the east. The latest tunnels to be placed under contract are the two tunnels of the New York & Long Island R. R. to run from Third Ave. and 42d St., New York City, under the East River to a connection with surface electric roads on Long Island. At the Manhattan terminus a large subterranean station will be excavated, about 80 ft. below the level of the Manhattan subway lines. The great air capacity required in present-day submarine tunnel work is well illustrated by a contract just closed for air compressors by the Degnon Contracting Co., which has the contract for building these two tunnels. The company has just ordered from the Ingersoll-Sergeant Drill Co. 14 air compressors of two different types. Eight are of duplex compound Class "HC" pattern with steam cylinders 16 and 28 ins. in diameter; air cylinders 25¼ and 16¼ ins. in diameter, and a stroke of 16 ins. Each unit has a free air capacity of 1,205 cu. ft. per minute. The other six are of straight line Class "A" type, with a 24-in. steam cylinder, 26¼-in. air cylinder and a stroke of 30 ins. The capacity of each is 1,444 cu. ft. per minute. The aggregate free air capacity of the fourteen compressors is 18,304 cu. ft. per minute. The shield method will be used in driving these tunnels. The straight line compressors will furnish air to the headings for keeping out the water, and will also supply intake air to the other machines. The compound units, drawing their air at discharge pressure of the low pressure machines, will furnish air at high pressure to the rock drills and other machinery in the tunnel bores. As at present planned, the work of driving these tunnels contemplates three shafts. One will be at the Long Island terminus; another at 42d St. and the river front in New York. The third will be on Man-o'-War's Reef in East River, and some interesting work will be done here in providing room for a power plant. Ultimately it is expected that quite a large island will be made here with the rock removed from the tunnel. From this central shaft, the tunnels will be driven in both directions. The fourteen compressors will be distributed among the three plants. This last order makes a total of 54 Ingersoll-Sergeant air compressors in use or contracted for on subaqueous tunnels entering New York City. The aggregate free air capacity of these machines is 138,426 cu. ft. per minute, and the pressures delivered range from 30 to 150 lbs.

THE FIRST-CLASS BATTLESHIP "MISSISSIPPI," is to be launched on Sept. 30 at the Cramp shipyard in Philadelphia. The general dimensions and features of the vessel are: Length, 382 ft.; breadth, 77 ft.; mean draft, 24 ft. 8 ins.; displacement, 13,000 tons; main battery, four 12-in. guns in pairs in turrets, eight 8-in. guns in pairs in turrets, eight 7-in. guns in broadside, two 18-in. submerged torpedo tubes; secondary battery, twelve 3-in. 14-lb. rapid-fire guns, six 3-lb. semi-automatic guns, two 1-lb. automatic guns, two 1-lb. rapid-fire guns, two 3-in. field pieces, two 0.30 caliber machine guns, six 0.30 caliber automatic guns; Armor belt, 9 ft. 3 ins. wide and 9 ins. thick for 244 ft. amidships, decreasing to 4 ins. thick at stem and stern; triangular athwartship armor in wake of water line belt, 7 ins. thick. The vessel is to have a trial speed of 17 knots, and a coal-carrying capacity of 1,750 tons. The engines are vertical twin-screw, triple-expansion, three-cylinder engines of 10,000 I.HP. combined capacity, with a steam pressure of 250 lbs. per sq. in. at the engines. Steam is supplied by eight water-tube boilers, placed in four water-tight compartments. Machinery, tools, stores and spare parts will weigh about 1,050 tons. The vessel will be lighted by electricity. The

contract price is $2,999,500. On Sept. 1, 1905, the vessel was 38.71% completed. The vessel's complement is to be 34 officers and 686 men, including 60 marines.

VESSELS NOW BUILDING FOR THE U. S. NAVY number no less than 32, comprising 13 first-class battleships, 6 armored cruisers, 3 protected cruisers, 2 training ships, 2 scout cruisers, 2 torpedo boats, and 4 destroyers. The battleships are in the following stages of completion (Sept. 1, 1905): "Virginia" 92.89%, "Rhode Island" 93%, "New Jersey" 80.3%, "Louisiana" 86.4%, "Georgia" 86.44%, "Connecticut" 86.15%, "Nebraska" 79.58%, "Minnesota" 71.16%, "Vermont" 61.4%, "Kansas" 60.1%, "Mississippi" 38.71%, "Idaho" 33.60%, "New Hampshire" 18.2%.

In connection with these figures the Bureau of Construction & Repair of the Navy Department gives figures showing the progress of completion of the "Louisiana," being built at a private yard, and the "Connecticut," at New York Navy Yard, in their race for completion. As is well known, in order to determine the merits of private ship building as against ship building by the government at the different navy yards these two vessels were authorized by Congress to be built in competition. The "Louisiana" got off first and held a good lead during the preliminary stages of the race, but soon after launching the "Connecticut" made rapid strides and overtook the "Louisiana." Since then it has been nip and tuck, neither one showing a decided advantage. Now the "Louisiana" is again drawing away from her rival, being one quarter of one per cent. in the lead.

FIRE TESTS OF MORTARS AND CONCRETES are to be undertaken by a joint committee representing the several organizations which had planned independent tests. The program for the investigation of fuels by the United States Geological Survey includes tests of the fire resisting qualities of cement mortars and concretes. It has also been proposed to carry on similar studies under the joint direction of the National Fire Protection Association and the National Board of Fire Underwriters at the Underwriters Laboratories in Chicago. The Joint Committee on Concrete and Reinforced Concrete of the American Society of Civil Engineers and affiliated societies, the National Association of Cement Users, the Association of American Portland Cement Manufacturers and the Concrete Block Machine Manufacturers' Association also contemplated making similar investigations. In order that these tests should be exhaustive it was deemed inadvisable for the various organizations to proceed on independent lines, but to unite in a joint investigation. In response to a call by Mr. Richard L. Humphrey, representatives of the various organizations met at the House of the American Society of Civil Engineers, New York, on Sept. 5, 1905. The object of the meeting was explained and after some discussion it was decided to organize a committee for the joint investigation of the fire-resisting properties of cement mortars and concretes by the above-named societies. The committee organized by the election of Mr. Richard L. Humphrey, Chairman, and Mr. Robert W. Lesley, Secretary pro tem.

A plan for the proposed investigations was submitted by the chairman and was discussed at length, and as amended was adopted as follows:

The first series of tests will be made on sand mortars, no facing being used in the manufacture of the block, which will be of a standard size, 9 × 12 × 24 ins. Another series will be made, using dry, medium and very wet mixtures, using three grades of mortars for each condition, viz: rich, medium and lean. A series of blocks will be made under the direction of the Committee of the Concrete Block Manufacturers' Association, in accordance with common practice. It is proposed to build a test oven. Three blocks of each series will be submitted to the test, two with the face towards the inside of the furnace and one with the back of the block facing the inside of the furnace. The blocks are to be laid in lime mortar, and four 3-in. diameter Bunsen burner jets with a firebrick baffle will be used for heating the furnace. It is proposed to raise, at a uniform rate, the temperature of the test oven to a temperature of 1,800° F. during a period of 1½ hours and maintain this temperature for 30 minutes. It is then proposed to turn two streams of water of 20 lbs. pressure at the nozzle, against the inner walls of the test chamber from points diagonally opposite each other, for a period of five minutes. At the conclusion of the test, wherever possible, it is the intention to make a determination of the strength and other physical properties.

COMPENSATION TO THE CONSULTING ENGINEERS to the Isthmian Canal Commission has been fixed by an executive order of President Roosevelt, which reads as follows:

It is ordered that each member of the Advisory Board of Engineers upon plans of the Panama Canal shall be allowed $5,000, payable upon the completion of the report of the board. In addition thereto he shall, when on duty with the board, be allowed $15 per day for personal expenses from the date of leaving his home until his return thereto, including Sundays and holidays. He shall also be allowed the actual cost of transportation incurred by him in travel on duty in connection with the board, to include cost of ticket by railway or steamer, sleeper or parlor car accommodations, baggage transfer, cabs and porterage.

It is further ordered that the allowances of $5,000 to Gen. Davis and Gen. Abbott shall be increased by the amount of their retired pay for the time during which they are employed upon the work of the board, it being my intention that these members of the board shall receive the same compensation for this work as the other members, and this increase being made to provide for the usual deduction of retired officers' pay.

THE STEEL DAM noted on p. 266 of our issue of Sept. 14, 1905, will be 65 instead of "75 to 80" ft. high, as there stated. It will extend across the Missouri River, about 18 miles from Helena, Mont., and will have a spillway 500 ft. long. The dam will be of structural steel and plate construction, with concrete foundation, abutments and core walls, and its entire length will be about 1,000 ft. The dam will be built for the Helena Power Transmission Co., which has placed the contract with the Wisconsin Bridge & Iron Co., of Milwaukee, Wis.

PERSONALS.

Mr. Archibald Glassco has been appointed Bridge Engineer of the Grand Trunk Pacific Ry., with headquarters at Montreal, Que.

Mr. John G. Little, structural engineer, has been transferred from the Navy Department for duty in the U. S. Reclamation Service.

First Lieutenant Robert R. Ralston, Corps of Engineers, U. S. Army, has been ordered from San Francisco, Cal., to Washington, D. C.

Mr. Ansel Brooks, M. Boston Soc. C. E., has been appointed Assistant Professor of Mechanics and Mechanical Drawing at Brown University.

Mr. J. B. Cowen has become connected with the General Storage Battery Co., 42 Broadway, New York, as Manager of the Sales Department.

Mr. George C. Millet has been appointed Chief Engineer nd General Superintendent of the Ohio River & Columbus Ry., with headquarters at Ripley, O.

Mr. Charles R. Steiner, Assistant Engineer in the U. S. Reclamation Service, has been transferred from the Denver, Colo., office and assigned to duty on Pathfinder Dam.

Mr. Charles H. Pierce, draftsman with the Lake Shore & Michigan Southern Ry., at Cleveland, O., has been appointed Instructor in Theoretical and Applied Mechanics at the University of Illinois.

Mr. John E. Hill, Assoc. M. Am. Soc. C. E., Professor of Civil Engineering at Brown University, while on leave of absence during the college year 1905-1906, will be associated with Hering & Fuller, of New York City.

Mr. W. L. Elkin, formerly assistant on the engineering corps of the Pittsburg Division of the Southwest system of the Pennsylvania Lines, has been appointed Assistant Engineer of the Michigan Division of the Vandalia R. R.

Mr. Henry B. Drowne, Jun. Am. Soc. C. E., formerly with the American Bridge Co., and recently with the State Board of Public Roads of Rhode Island, has been appointed Instructor in Civil Engineering at Brown University.

Mr. J. F. Witmer, M. Am. Soc. C. E., of Buffalo, N. Y., has become connected with J. G. White & Co., of New York, and will assume charge of special work for that company bearing on hydraulic engineering in foreign fields.

Mr. G. A. Collins and Mr. W. W. Corbet have formed a partnership under the firm name of Corbet & Collins and will engage in the work of civil irrigation and mining engineering. They will have their headquarters in Santa Fe, N. Mex.

Mr. H. P. Boardman has resigned his position as engineer in the Bridge Building Department of the Chicago, Milwaukee & St. Paul Railway, and is now a member of the engineering staff of the Fitz Simons & Connell Company, Contractors, of Chicago.

Mr. W. W. Gwathmey, for the past ten years Chief Engineer of the Seaboard Air Line Ry., and Mr. B. T. Mackall, Assistant Engineer, have resigned from that road's service and will enter shortly upon a general engineering and contracting business, with headquarters in Norfolk, Va.

Mr. C. A. Morse, Assistant Chief Engineer of the Atchison, Topeka & Santa Fe Ry., at Topeka, Kan., has been transferred to Los Angeles, Cal., as acting Chief Engineer of the Coast Lines in place of Mr. R. B. Burns, who has been granted a leave of absence, owing to ill health.

Mr. Eugene Holcomb, formerly in immediate charge of the Westinghouse Companies' interests in Argentina, has been appointed Manager of the newly created Foreign Department of Allis-Chalmers Co. He will have charge of all the foreign agencies and foreign selling representatives of the company.

Mr. R. E. Dougherty has been appointed Resident Engineer in charge of construction in the Exterior Zone of the New York Central & Hudson River R. R., south of Poughkeepsie on the main line, Newburgh on the West Shore, Putnam Junction on the Harlem Railroad, and including the Putnam Railroad and its branches.

Mr. Walter H. Whiteside, M. Am. Inst. E. E., was, on Sept. 7, elected President of the Allis-Chalmers Co., succeeding Mr. Benjamin H. Warren, of New York. At the same meeting Mr. Henry Woodland, of Milwaukee, Wis., was elected Treasurer, to succeed Mr. William J. Chalmers, of Chicago. Mr. Whiteside joined the Allis-Chalmers interests in July, 1904, as General Manager of Sales and has been, during the absence in Europe since April last of his predecessor in office, in full charge of the operations of the organization, with the title of vice-President and General Manager.

Mr. J. Francis Le Baron, M. Am. Soc. C. E., has resigned the position of Chief Engineer of the Louisville, Cumberland & Chattanooga Ry., and has been appointed Consulting Engineer of the United States & Nicaragua Co., and Chief Engineer of the Great Central Ry. of Nicaragua. Mr. Le Baron left Sept. 19 for Nicaragua, and on his way will stop at Belize, British Honduras, to make an examination and report on the new harbor to be constructed at the terminus of the railway that the Imperial Government has decided to build from the seaboard to the Guatemaylan frontier.

Obituary.

C. H. Burchinal, of Toledo, O., President and Manager of the Lake Erie Asphalt Block Co., died recently of typhoid fever.

Charles H. McCormick, President of the Board of Water Commissioners, of New Brunswick, N. J., died Sept. 13 at his home in that city, aged 60 years.

Elijah B. Phillips, formerly well known throughout the West in railroad circles, died Sept. 14 at his home in Brookline, Mass., aged 86 years. His last post was that of President of the Fitchburg R. R., now a part of the Boston & Maine.

J. M. Rowe and J. R. Funk, of Binghamton, N. Y., and H. O. Biesecker, of Lestershire, N. Y., three young civil engineers in the employ of the Delaware, Lackawanna & Western R. R., were killed by a work train Sept. 13 while returning to Cortland, N. Y., on a hand car.

General Isaac J. Wistar, of Philadelphia, a well known philanthropist and scientist, died Sept. 18 at his summer home in Claymont, Del. General Wistar was for a number of years vice-President of the Pennsylvania R. R. Co., and head of that corporation's coal and canal companies. At one time he was President of the Academy of Natural Sciences of Philadelphia.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 18 to 20. Annual meeting at Bethlehem, Pa. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 25 to 29. Annual meeting at Boston, Mass. Secy., Dr. Chas. O. Probst, Columbus, O.

AMERICAN STREET RAILWAY ASSOCIATION.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION.

STREET RAILWAY ACCOUNTANTS' ASSOCIATION.
Sept. 25-30. Annual convention at Philadelphia, Pa. Secy., T. C. Penington, 2020 State St., Chicago, Ill.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17. Annual meeting at Pittsburg, Pa. Secy., R. F. Patterson, Concord, N. H.

LAKE SUPERIOR MINING INSTITUTE.
Oct. 17, 18. Annual meeting on the Menominee Range, with excursion. Secy., A. J. Yungbluth, Ishpeming, Mich.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The first meetings of the society and its sections for the coming season are as follows: Meeting of the society, 8 p. m., Sept. 19, "Electric Motors and Their Applications," by W. E. Reed; Chemical Section, 8 p. m., Sept. 21, "A Cooperative Plan for Research Work," by J. R. Mardick; Structural Section, 8 p. m., Sept. 26; Mechanical Section, 8 p. m., Oct. 3, "Machine Shop Practice," by G. M. Campbell. All the meetings mentioned take place at the society's rooms, 410 Penn Ave.

NATIONAL ASSOCIATION OF MANUFACTURERS OF SAND-LIME PRODUCTS.—The annual convention of the National Association of Manufacturers of Sand-Lime Products will be held at the Hotel Cadillac, Detroit, Mich., on Dec. 5 to 7, 1905. The following papers will be presented; "The Scientists' Message to the Sandstone Brick Makers," "The Characteristics of a Good Sand and Its Proper Preparation," "Lime and Its Relations to Sand-Lime Products," "Best Method of Hydrating Lime and Grinding Lime," "Coloring Matter for Sandstone Brick," "Coloring Brick," "The Rotary Press," "The Vertical Press," "Liners," "The Kent Mill," "The Tube Mill," "The Dry Pan," "Dryers," "Hardening Cylinders," "Sand-Lime Blocks and Appliances for Same," "Standardizing Sandstone Brick," "Sandstone Brick from the Architect's Standpoint," "Sandstone Brick from the Contractor's Standpoint," "Marketing Brick," "It Pays to Advertise," "Insurance, How to Construct and Handle a Plant so as to Secure the Lowest Rate of Insurance," "Publicity in Showing the Advantages of Sandstone Brick," "Management," "Cost of Sandstone Brick," "Measuring Devices," "Approved Methods of Manufacturing Sandstone Brick." Detailed information about the meeting may be obtained from the Secretary, Mr. H. O. Dunn, Wilmington, Del.